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LABORATORY ENVIRONMENT OF PC TECHNOLOGY & DEVICE DESIGN

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Imad Abdulla
Bachelor's thesis
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PREFACE

This bachelor’s thesis was completed at the Oulu School of Engineering’s Raahe Campus during 2010 – 2011. Raahe Campus provided the subject and requirements for this bachelor’s thesis. The purpose of this thesis was to study PC technology from the view point of device design and laboratory exercises.

This thesis is a continuation for Okeyl Kevan’s bachelor’s thesis made in 2006. We want to thank our supervisor Juha Räty for his valuable advice during the course of this work.

Imad Abdulla and Markku Höglund in 2010

TIIVISTELMÄ

Oulun seudun ammattikorkeakoulu
tietotekniikan koulutusohjelma

Tekijä: Imad Abdulla
Opinnäytetyön nimi: Laboratory Environment of PC Technology & Device Design
Työn ohjaaja: Juha Räty
Työn valmistumislukukausi ja -vuosi: Autumn 2011 Sivumäärä: 76

Tämän opinnäytetyön tarkoitus on tuottaa laboratorioympäristö laitesuunnittelu-, PC-tekniikka- ja audioelektroniikkakursseille. Tämä sisältää laite-, ohjelmisto- ja audioteknisiä testejä ja laboraatioita.

PC-tekniikassa laitteita ja ohjelmistoja voidaan käyttää tietokoneiden ja ympäristön fysikaalisten toimintojen ja komponenttivalintojen aiheuttamia muutoksia. Näitä ovat mm tietokoneiden jäähdytysjärjestelmätekniikka, kastepiste sekä lämpötilan ja vastapaineen mittaus.

Laitesuunnittelussa tämä työ menee syvemmälle luoden joitakin simuloituja laitteita tai muokaten laitteiden ominaisuuksia, millä voidaan osoittaa näiden muutosten vaikutukset samoin kuin todellinen toiminta voisi aiheuttaa PC-tekniikkaympäristössä.

Audio tekninen osuus keskittyy melumittauksiin ja meluntorjuntaan. Kaikista aihealueista tehdään laboratoriotöitä.

Tämä työ on jatkoa Okeyl Kevan:in vuonna 2006 suorittamaan päättötyöhön, jossa näitä asioita on jo alustavasti pohdittu enempi keskittyen PC-tekniikkaan. Tein tämän dokumentin yhteistyössä Markku Höglundin kanssa.

Tässä projektissa käytämme normaalia tietokonejärjestelmää kaikkine tarvittavine komponentteineen, jotka ovat sisäänrakennettuja. Muutama ylimääräinen mittalaite liitetään tietokoneeseen jotta kaikki mahdolliset vaikutukset voidaan mitata ja mallintaa. Näin opiskelijat voivat aktiivisesti tarkkailla mikroprosessorin ja / tai muiden komponenttien lämpötilaa. Muita mittauskohteita ovat mm. tuulettimen kierrosluku, virrankulutus ja kosteuden lisäksi paineen mittaukset.

Tämä projekti voi olla hyvin hyödyllinen opiskelijoille, jos se pidetään oppimisprojektina. Olisi hyvin tärkeää tietää, miten pienillä muutoksilla voi olla suuria vaikutuksia esim. tietokonejärjestelmän suorituskykyyn. Suurin etu tässä projektissa on se, että opiskelijat voivat ymmärtää ja visualisoida fyysisiä muutoksia elektronisissa osissa ja niiden suorituskyvyssä.

Asiasanat Paineen mittaus, Kastepiste, Melusaastemittaus, Lämpötilamittaus, Tietokonekomponentit

ABSTRACT

Oulu University of Applied Sciences
Information Technology

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The aim of this bachelor's thesis was to carry out laboratory sessions to study device design, PC-technology and audio electronics. This includes device, software and audio technical tests.

In PC-technology, devices and software can be used to demonstrate of the physical effects of operation and the changes caused by the main parts of computers and surrounding environment such as a cooling system technology, a dew point, a temperature and back pressure measurements.
The device design goes deeper into creating some simulation devices or modifying device to demonstrate these effects as a real operation that can act on a PC- technology domain.
Audio electronics is focusing on noise measurements and noise abatement. All topics are subjected to laboratory work.

This thesis continues the bachelor's thesis made by Okeyl Kevan in 2006. I made this thesis in collaboration with Markku Höglund.

In this project we were using a normal computer system with all the necessary components built in.
A few additional measuring devices were attached to the computer in addition to separately simulate devices in use. So students can actively observe the temperature of the microprocessor and /or other components. Other possible measurements are a fan rpm, a power consumption and an air moisture as well as a pressure measurement.

It is very important to know how small effects can make big changes on the performance of a computer system. The main benefit of this project is that students can understand and visualize the physical changes in electronic parts and their performance.

Keywords Pressure measurement, Dew point, Audio noise level measurement, Temperature measurement, PC component, Device design

TABLE OF CONTENTS

1 INTRODUCTION

Computer is an integral part of everyday life. We use the Personal Computer (PC) to perform various tasks. It is an electronic device that accepts, stores, and processes the data and returns the result or output.The development of the modern day computer was the result of advances in technologies and man's need to quantify. As we know, device design is a field of engineering science, which concentrates more on power and heat designing instead of function executed by a device.

When the device in use is burdened - is it a computer or another electronic device – the power consumed by it changes to heat. This means problems. If cooling is poorly designed, or there is none the device is heated too much and its components start to work incorrectly. Especially' this problem comes out in portable computers, where many functions must be installed in a tiny space. Actually, computers of today are particularly problematic with a heat production.

Some motherboards are usually already equipped with sensors and there is software like Intel Active Monitor which can be used to monitor the temperatures of a motherboard and fan speeds without making any other electronics devices.

The purpose of this bachelor's thesis was to create a laboratory environment for studying the device design related with a PC- Technology work environment.

2 THE WORK ENVIRONMENT

The aim of this bachelor's thesis was to create combined lab exercises for PC-technology and device design. The work environment is a computer laboratory with a computer and software installed. Because the aim was to concentrate on this problem from the view point of the thermal design, the rotation direction of the fans must be reversible and speeds adjustable. In addition, the computer is equipped with a counter pressure measurement which tells the pressure difference between out and inside of the enclosure.

One thing to measure is the noise pollution caused by cooling. The cooling implemented with fans keeps usually some noise. The working of this kind of cooling is based on the breaking laminarity of air around the components and in that way it makes thermal transition better. Moreover the fans remove a warmer air away from the critical areas and replace it with a cooler one. Beside the fans also other mechanical devices in a computer cause noise pollution. The worst source of heat in a computer is the processor. The heat production of the processor is affected by the used voltages and the consumption of currents. The latter is directly affected by processors load.

Not only you can speed up your computer by tailoring processes in a startup and removing unnecessary services, but you can also affect its temperature.

We have divided the work environment into three sections, although the three sections are interrelated in terms of integrated action.

1. Computer technology
2. Device design
3. Audio Electronics

2.1 PC-Technology

PC- technology includes all domains related to a computer in terms of hardware and software that may explain in detail the mechanism of this electronic device, consisting of many electronic and electrical parts. Also, it defines the fundamentals of the work of these components in all physical and mathematical aspects, such as explained in Okeyl Kevan's bachelor's.

As we know, all electronic devices, because of their small size and the space converged with each other, generate heat. They are exposed to high frequencies when they are operating on board, that will lead to a shortage of capacity and will reduce their functional life.

Changes in some physical factors of electronic components, such as a change of their temperature or an exposure to influential factors, such as humidity or pressure will lead to a change in the characteristics of the process, and thus will lead to a poor performance or damage.

In this study of computer technology, we will study the effects that will change the performance of computer' components when affected by a temperature change, as well as pressure and humidity factors, and how to solve these problems by providing techniques to avoid the problems caused by heating and the use of appropriate equipment for this purpose.

2.1.1 Temperature effects

When the temperature rises in the human body, what happens to that person? Of course, he/she will get tired and get a headache. That can happen with computers, too.

Because the personal computer is depending on the electricity, which feeds the various units of computer and electronic cards, it is expected to result in electrical consumption and heat. The amount of produced heat is varying from each device according to its task. There are two units that are producing a great amount of heat in the computer. They are a power supply and a processor. Therefore, it is important to have a way to get rid of the temperature rise of these two units, which will occur by cooling the system. There is an unspoken rule in the computer' field that the rise in temperature means a bad performance. Whenever the temperature of units is high, the level of performance is low. So, the increased heat will burn and damage the unit.

Generally, a PC doesn't need a large amount of electricity when operating, but with additional units and new electronic cards, this may lead to increase in the amount of electricity needed to perform their work in a good way. Also, when the computer' unit doesn't get enough electricity to do their work, it will lead to some kind of problems such as temperature rising in these units.
Some of the modern electronic cards, such as graphics cards which have their own processor, may cause increased loads inside the computer. So the computer needs to develop the power supply. A PC needs normally 300 watts, but in the case of additional units or electronic cards, it is preferable that the computers power generator have 350 or 400 watts. [1]

There is a major computer' fan above or beside the power supply and it pulls the hot air out of the computer' case. The second fan is installed over the processor with a heat sink, because it is known that the main processor is producing a high temperature. Therefore it needs a cooling system, and fan is a part of this system.
Metal plates are installed near or over the surface of modern processors. These metal plates are called heat sinks. They absorb heat that comes out of the processor and distribute it on the surface of the heat sink, and fan is playing the role to cool this surface to reduce its temperature.

Modern processors are provided with sensitive parts that are related to the fan's work. The processor is also dependent on the fan's work. When the fan stops working for some reason, the temperature doesn't rise and cause the burning or damage, because the unit is equipped with a mechanism that shuts the processor down. Some modern electronic cards, which produce high temperatures, may have own fans, such as graphics cards.
To avoid the temperature problems, there are many important things to pay attention to, such as:
- To keep the computer in a place that has good ventilation.
- Don't put the computer in an enclosed space, near heat generators or very warm places.
- Don't put things in front of the vents to block the air movement.
- The cables inside the computer's case should be neatly installed, so the intertwined cables will not impede or reduce the efficiency of the air paths.

2.1.2 Heat transfer

The heat transfer occurs as a result of the difference in temperature. It always occurs from hotter objects to colder objects, and this is confirmed by the second law of thermodynamics. The heat transfer between nearby objects cannot be stopped, but could be slowed. The heat transfer is the transfer of thermal energy from the hotter cluster to the cooler cluster. Thermal energy is also called as a heat exchange. The heat is transmitted in four ways: conduction, convection, radiation and mass transfer. In our labs we are focusing on the conduction and convection ways of measurements. For these measurements we created an artificial processor to be used as a simulation device to produce the heat like in a real processor. It consists of many resistors connected parallel to each other. In addition, it built-in temperature sensor can connect to a digital temperature measurement device. With this device we can measure many cooling activities in different situations. [2]

2.1.3 Pressure effects

In cooling process there are fans that create the air currents. That air has weight such as all materials naturally have. As the result of the air weight effect, the pressure is produced. This pressure is inversely proportional to a degree of air temperature. If the temperature rises, the air will extend and get less density, then the weight and pressure are decreasing. And vice versa, if the temperature drops, the air will compress and the weight will increase.

Adding water vapor to the air (which makes the air humid) reduces the density of air. Generally, it is known that the room air, which is naturally saturated with the water vapor, is relatively more humid than a computer's case. The variation in temperature and pressure between them will increase the humidity, which may lead to a short circuit between the electronic parts. This relationship can be calculated using the ideal gas law, expressed as a function of temperature and pressure:

$$\rho = \frac{p}{R_{\text{specific}} \cdot T}$$

Where: [3]

ρ is the air density

P is absolute pressure

R_{specific} is the specific gas constant for dry air

T is absolute temperature

In the lab the U-tube manometer was the device that was used to measure the pressure. In addition, two fans were added to the computer's case to create the required target.

2.1.4 Cooling system technology

The computer cooling process has become a very important system. Whether a device is a desktop computer or a server, the cooling has become an essential part of the requirements of the device.
Without the cooling system in the hardware (Processor, graphics card, motherboard, memory chip and other hardware), the lifetime of the components will reduce, and thus a lot of money will be spent on trying to fix the problems caused by the temperature.
To avoid all these disasters and to increase the working efficiency, you have to install a cooling system to your computer to protect it from the danger of a high temperature.
There are two basic types of cooling, the air cooling and the water cooling. Nowadays the most common is the air cooling. In addition, there are other types of cooling systems, such as a peltier cooling or an Extreme (below-zero) super-cooling. We have used only one element of this system in our lab, which is the peltier element.

The air cooling system is the most prevalent. The idea of this type depends on the heat sink, which is a metal object or a component that transfers the heat generated within a solid material to a fluid medium, such as air or a liquid. It is designed physically to increase the surface area in contact with the cooling fluid surrounding it, such as the air. Also it is using a fan for pumping the ambient air through the heat sink to cool the body.

The air cooling system including a heat sink without a fan is called a passive cooling, whereas a system including both a heat sink and a fan is called an active cooling. We have used in our lab work both the passive and active cooling to view the difference between them. In addition, we have used the artificial processor and temperature measurements device.
There are some important things that must be taken into account when choosing the air cooling system, such as heat sink properties and fan properties. [4]

2.1.5 Heat sink

There are different types of heat sinks because several companies are manufacturing them (Figure 1), i.e. there are different forms, sizes and different raw materials.

The conductivity of a metal is greater than the conductivity of air and the conductivity is the ability of an element to transfer heat from and to it. A big surface area, which is in touch or in contact with the object to be cooled, is better for losing the temperature than a small surface area.

Usually the heat sink is manufactured from a copper or aluminium metal. The conductivity of copper is better than that of aluminium because the ability to radiate heat is higher for copper than for aluminium.

Another thing you should pay attention to is the size of the heat sink. The heat sink size should match the space available in the computer's case. If the area inside the case is small, the size of 80mm to 90mm is suitable. If it is large, the size of up to 120 mm is enough. [5]

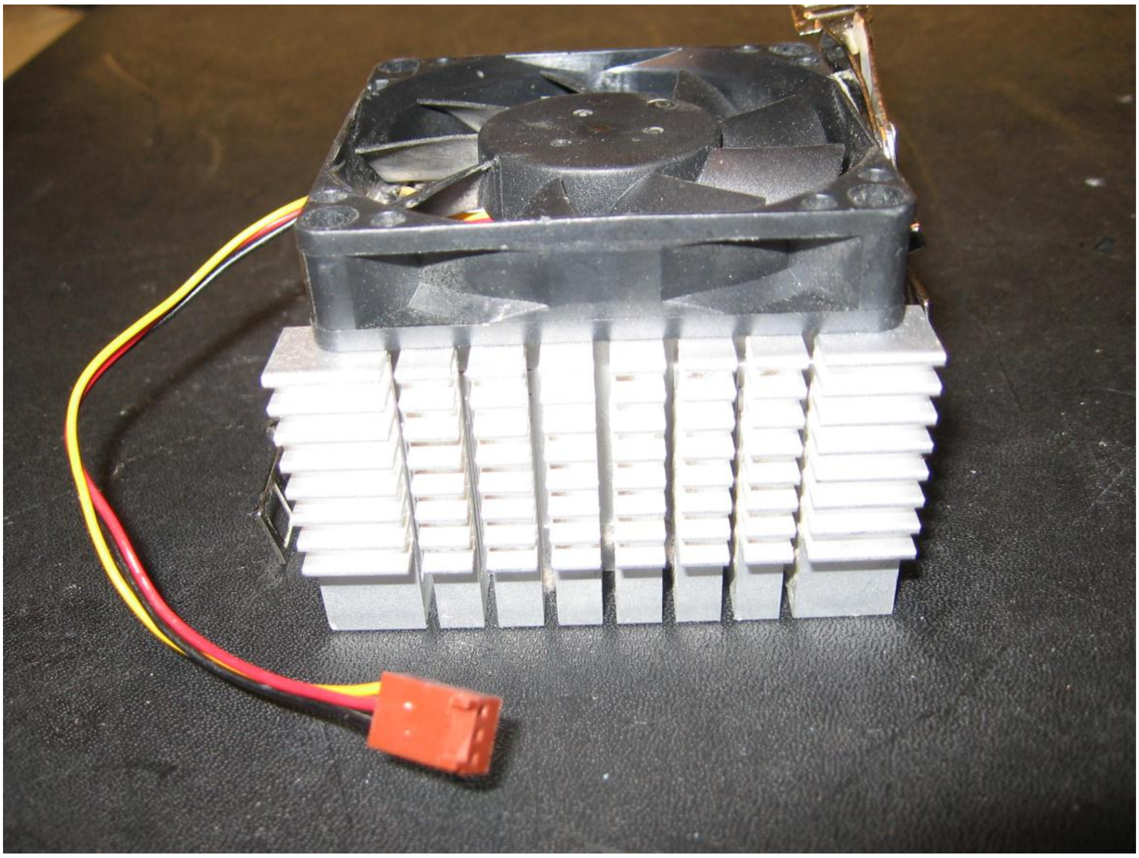


Figure 1: Heat sink with a Fan

2.1.6 Fan

A fan is the second necessary part in an air cooling system. So there are some important things to bear in mind about the fan, such as the size, the amount of air, the speed of the fan and power consumption.

The size is identified by the flowing marks (## x ##x ##). The former mark refers to the length and width of the fan and the latter refers to the height.

The amount of air is measured by CFM (Cubic Feet per Meter). This value indicates the amount of the air that a fan can drag from the surrounding air and pump to the heat sink. The fan is more capable of cooling when that value is high.

The speed is measured by RPM (Rotation per Minutes). A fan with long wings is slower in speed than a fan that has short wings, but in contrast the noise level from a fan that has short wings is high. Consequently you should choose well between the speed, size and noise level (RPM, CFM and dB’s (Decibel))

An electricity consumption or a power consumption is always written on the fan with the value of electricity consumption in amperes (A). Most of the fans consume 12 volts and to calculate the amount of consumption you have to multiply the value of amp consumption by 12 volts to get the value of watt, which is the value of electricity consumption.
For example, for a fan requiring 0.3 amps, the value of power consumption will be 0.3 x 12 = 3.6 watts.

Before installing the fan (Figure 2), we should also make sure that the number of wires is known, because some fans have 2 wires, and others have 3. 2 wires (black and red) are always used for positive and negative poles while the third (yellow) wire is used to control the fan speed.
There are some necessary things that should not be forgotten, such as the dust which reduces the efficiency of the fan. Cleaning is advisable at least once every 3 months.

The artificial processor and Temperature measurement device are the equipments tools in our system cooling lab to visualize the idea of cooling effects. [6]

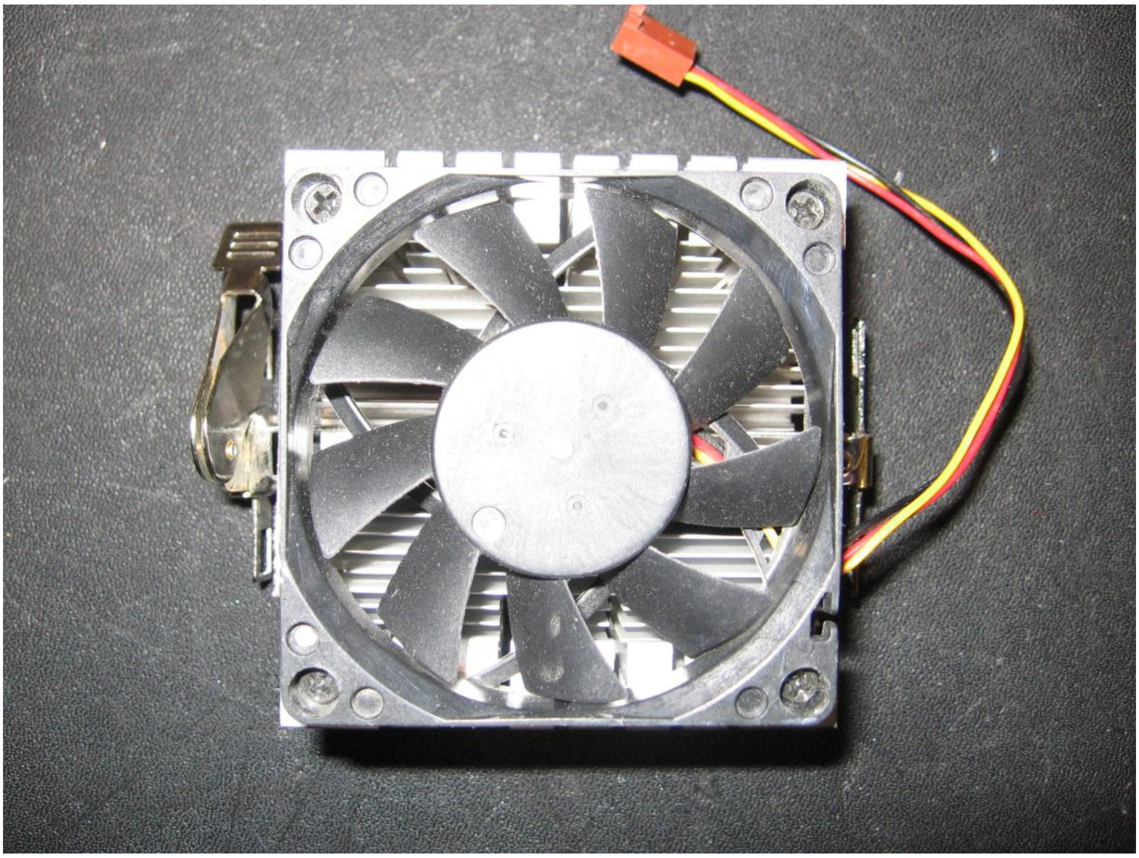


Figure 2: Fan with a Heat sink

2.1.7 Moisture

Air humidity or humidity is the amount of water vapour in the air. If we cool a certain amount of air to certain temperature it will become saturated with a water vapour, so the actual water vapour pressure equals the saturated water vapour pressure. If the relative humidity reaches 100 %, it is called the dew point. Whenever the temperature of the dew point is high, the content of air humidity is high, and vice versa. From this reason, for example, the air in the midwinter in Finland is very dry having only 10 % relative air moisture.

Many electronic devices have humidity specifications, for example, from 5% to 95%. At the top end of the range, the moisture may increase the conductivity of permeable insulators leading to a malfunction. Too low humidity may make materials brittle. A particular danger to electronic items is a condensation, which can lead to a short circuit inside the equipment. [7]

To understand this idea, we made a moisture simulation device, which can show the effect of a humidity operation and the dew point measurements.

2.2 Device Design

Einstein said, the imagination is more important than knowledge, so all devices start with an idea. It might not be much of an idea, but you have to start somewhere. However, most ideas are bad. You can make a device from a bad concept, but usually the result is not good. Sometimes bad ideas can be refined into good concepts with an effort and an ability to tell when the initial idea is bad. [8] (Designing Devices 2010, date of retrieval 20.10.2011)

In general, ideas come from two main places: creating something entirely new, or combining existing pieces into a new whole. So, to get the result of any test, you must have the appropriate tools or equipment for them. These tools and devices help reaching the result and the objective to be achieved.

In order to carry out the tasks required, we used some of the services available in the market, such as a thermometer with the establishment of some modifications to it by us. In addition, we have created some devices from the core of our ideas to simulate the process of cooling and humidity. Also, there are a pressure measuring device and an artificial processor.

When we talk about device design, we must not forget the role of software to do a lot of tasks without relying on equipment designed to perform these actions. Such software came with the BIOS to control the temperature of the processor and the work of the fan. There are also a lot of programs provided by the manufacturers of motherboards and processors to monitor the performance of processor and embedded devices built-in. They are available for operating systems, like Intel Company.

Here is the list of devices we have used in our labs:

1. Desktop computer.
2. Digital Thermometer.
3. Artificial processor.
4. Additional fan with a heat sink
5. U-Tube Manometer
6. Humidity simulation device
7. Noise pollution measurement device.

Device concepts are most interesting when they use a new technology to solve an old problem or they use an old technology to solve new problems.

2.2.1 Desktop computer

Each computer has its own specifications different from another computer in terms of manufacturer, performance and electronic parts built-in. We have chosen one of the labs computers that is compatible with the requirements of our work with addition of some amendments. These amendments are 2 fans added to a computer case that can play many roles for viewing the effects which will occur inside the computer, such as:

- Pressure created
- Increase cooling operation
- Difference between internal and external pressure
- Determine the proportion of noise generated by a fan
- Changes in temperature of cooling system
- Changes in power consumption

In addition to fans, a U-tube manometer was added to it. It will show the differences of pressure between the inside and outside of the computer case.
Properties of this computer are shown below (Figure 3, Figure 4).

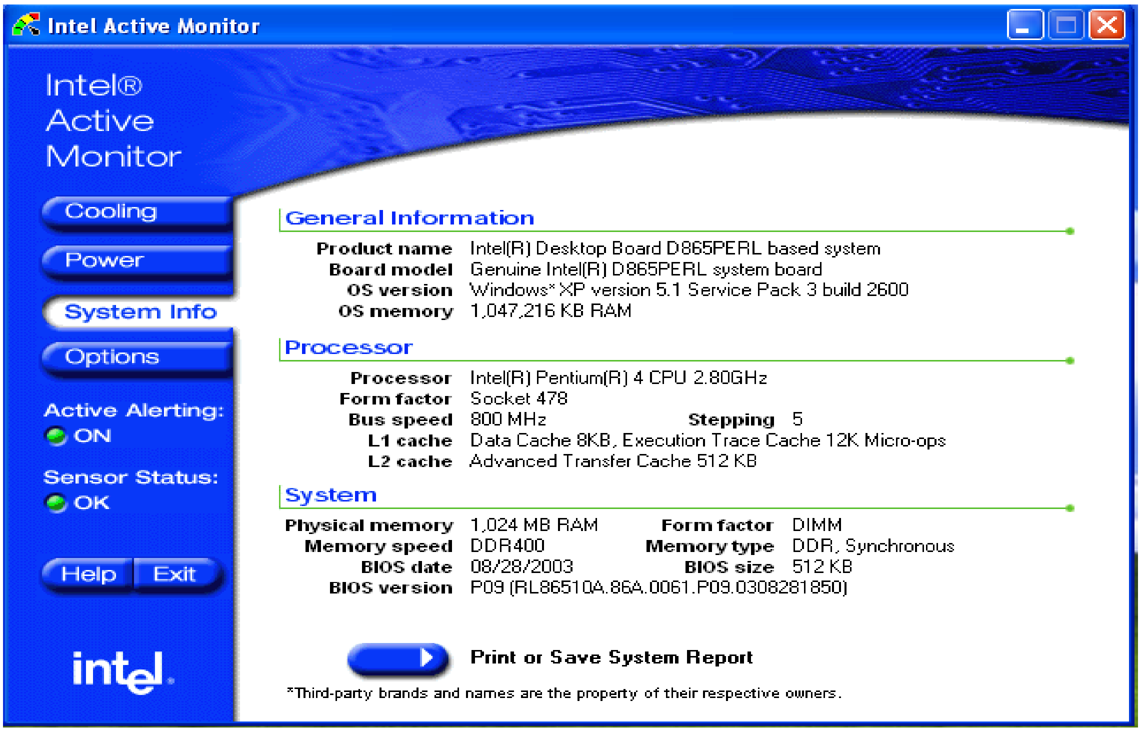


Figure 3: Computer System Information

Figure 4: Desktop computer

2.2.2 Digital Thermometer

This device is a temperature measurement tool which is used almost in every required process for temperature measurements. This device has been modified to be portable so it has the ability to measure the temperature of any element or device in the target labs. We have followed some steps similar to that carried out by Okeyl Kevan.

The internal construction of this device consists of three main components, such as a microcircuit ICL7107, a CMOS-circuit 4049 and a 7-Segment display and many passive and active electronic components.

Microcircuit ICL7107 is a very capable 3 ½ - numbers A/D (analog / digital) – converter including all active circuits that are needed (including a driver for a 7-segment display), a comparator and a clock. ICL7107 is driving the 7-segment display directly.

7-Segment display

Most common way to produce visible numbers from digital signals is to use a pattern made from seven lines (segments) as shown in the picture below. The segments in the display units are LEDs. Every LED segment can be separately driven with current, so that all the numbers can be made from zero to nine. In all segments there is also one other led with those seven segments LED: s. that is for decimal point. Depending on the type of your display there are either anodes or cathodes connected together. The display element of this device is a common anode type. (Kevan 2006, 69)

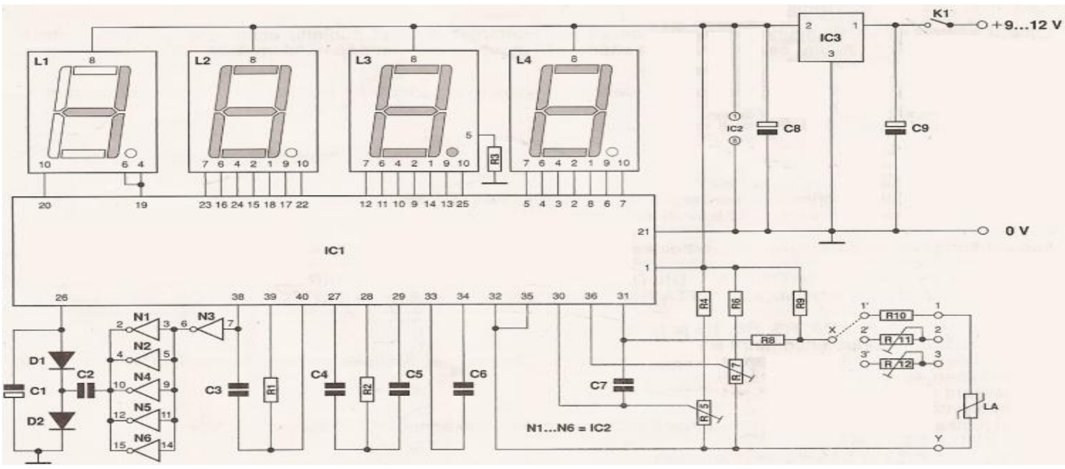


Figure 1 Schematic of measurement

CMOS-circuit 4049 includes six NO-gates. There are two different looking signs used from NO-gate. In NO-gate a digital state of input is going to be inverted to a reversal state of output. The actions of the gate are represented in the form of a truth table. Zeroes are equivalent to a zero-state in the digital transformation of date transfer. This means that, the voltage to be measured is close to a zero voltage. And if the state is 1, the voltage is close to the supply voltage.

The supply voltage in the temperature measurement is stabilized with 5 V regulators IC3. The maximum supply voltage for IC3 and IC1CL7107 is 6 V. The microcircuit IC1 also needs a negative voltage for a pin 26. The RC-oscillator (R1, C3) and the parts inside IC1 are combined to a clock circuit. The clock pulse (pin 38), the microcircuit 4049 (IC2) NO-gates, the diodes D1 and D2, the capacitor C2 and with aid of electrolyte capacitor can be about -3, 5 V made to a pin 26.

If the values of the components are as follows: R1=100 K ohm andC3 100pF, the frequency is 48 KHz (3 samples per second). If you wish to change the sample rate, the value of C3 is to be changed (for example to 560 pF) (One sample between 2 seconds). For the power supply of unit, a 2, 3, 4 or 5 V battery can be used combined to a serial or/ and other 9 V power supply. The use of a normal 9 V battery should be avoided because of the very high power consumption of the measurement. (Kevan 2006, 70)

2.2.3 Calibration

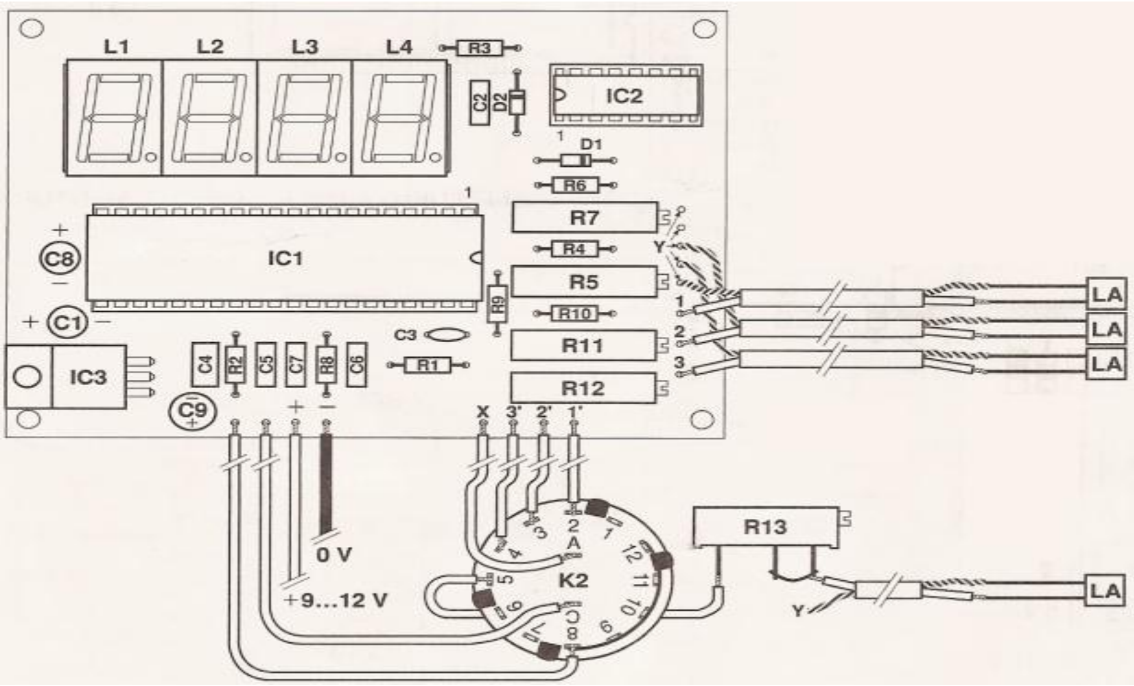
Calibration is made in two phases:

First, the first temperature sensor (bare wires must be protected with epoxy (for example) is placed in to water which has ice in it. When the ice has partially melted, the multi revolution calibration potentiometer R5 is used to set 0.00 to the display.

After that, the same sensor is placed into boiling water and the multi revolution calibration potentiometer R7 is used to set a reading “100.0” to the display. (Kevan 2006, 71)

2.2.4 Extra sensors for temperature

If you wish to connect more than one temperature sensor to the measurement, a jumper wire (X-1) and a switching connector K1 are not needed. Besides that you will need a revolving connector K2 (2 x 6 –position) and a multi revolution calibration potentiometer (100 Ohm) for each extra temperature sensor. Also, you need a suitable and protected lead for each sensor. With K2, you can connect 5 temperature sensors to the measurement.



Connection of multiple temperature sensors

The revolving connector is connected with leads as shown in the part location picture. When you want to connect more than 3 temperature sensors in the measurement, the fourth and fifth sensor and their multi revolution calibration potentiometers (R13, R14) are directly together without the use of a circuit board. The leads of the fifth sensor are not shown in the part location picture, but the leads will be done the same way as with the fourth sensor, only that the pin number 6 is chosen from the switch. The pins 8, 9, 10, 11 and 12 are connected together from around circle with a connection wire so that the current can be switched to the device from multiple positions.

In the revolution switch, there is a limiting plate under the board, which can be used to limit the positions of the switch at the count of the sensors. For example, if only three sensors are connected, the switching must be limited to 4. (In the first position, the current is switched off from the device) Numbers are in front of the switch, beside the holes. Before placing the limiter plate, the switch is turned counter clockwise to the maximum point. So the limiter plate is placed as stated in the example (according the count of the sensor) into the correct hole.

After that the measurement is calibrated with the aid of the potentiometers R5 and R7, using the first temperature sensor. All the temperature sensors are placed in (open leads must be protected with epoxy) the same water bucked. After that, the revolving switch is used to switch display readings from each sensor and to calibrate it to state the reading of the first sensor by using the multi-revolution calibration of the stated sensor (R11, R12, R13 or R14).

Passive and active components constructed in the temperature measurement device.

R1, R4 , R6	100 KΩ	Resistor
R2	470KΩ	Resistor
R3	680Ω	Resistor
R5,R7	100KΩ	Resistor
R8	1MΩ	Resistor
R9	5,6 KΩ	Resistor
R10	47Ω	Resistor
R11*,R12*,R13*,R14	100Ω	Resistor
C1	10µF	Capacitor
C2,C5	47nF	Capacitor
C3	100pF	Capacitor
C4	220nF	Capacitor
C6,C7	100nF	Capacitor
C8	47µF	Electrolyte capacitor
C9	100µF	Electrolyte capacitor
D1,D2	1N4148	Diode
IC1	ICL7107	Integrated circuit
IC2	4049	Integrated circuit
IC3	7805	Regulator
LA	KTY10	Temperature Sensor
L1,L2,L3,L4		Temperature Sensor
K1**		Switch
K2		2 x 6 position switch

(Kevan 2006, 71-73) [9]

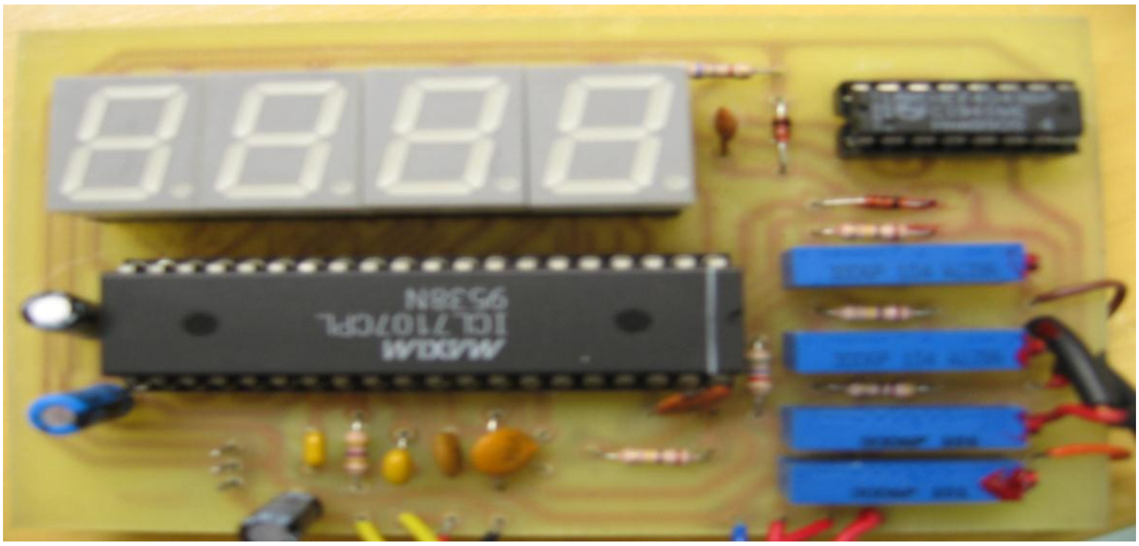


Figure 5: Digital Thermometer board

Digital thermometer (Figure 5, Figure 6, and Figure 7) has been modified to be a portable device. We can use it everywhere to measure the temperature. It has been modified as follows:

1. All sensor places are ready to be used. Two of them are connected with long cable sensors and other places have sockets to connect sensors to the device.
2. All components are combined in a black box.
3. A switch button (On / off) has been added.
4. A sensor channel switcher and a power source socket are installed on the black box.

Figure 6: Digital Thermometer temperature display

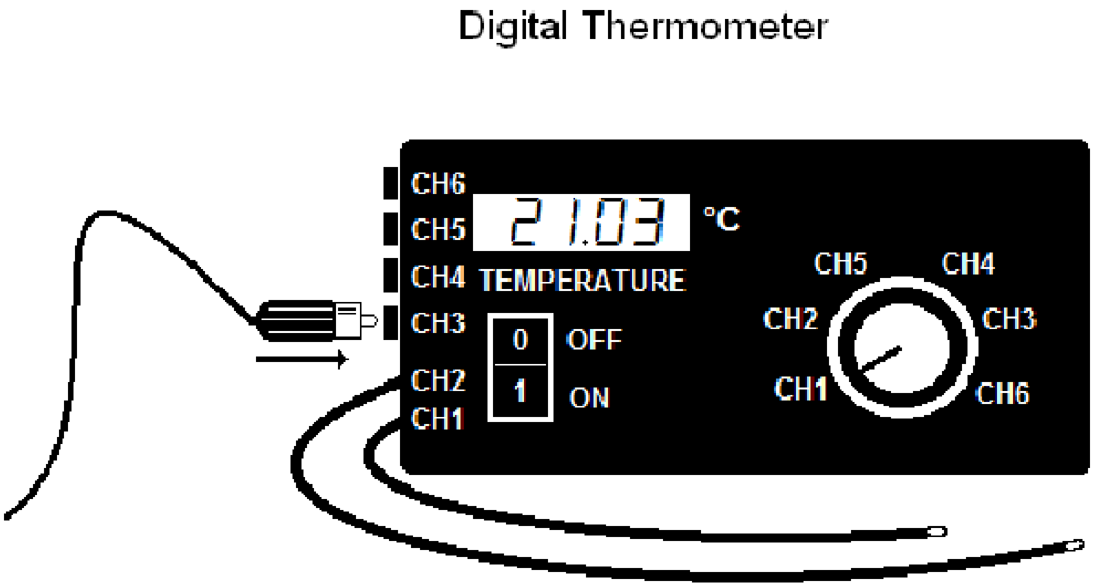


Figure 7: Illustration Picture for digital thermometer

2.2.5 The artificial processor

The artificial processor (Figures 8, 9, 10) is a device created to simulate a heat producing real processor. It consists of many resistors connected to each other in parallel. It is like a network of resistors consisting 100 pieces of carbon film resistors, each resistor has a value 560 Ω extending together on 7 x 7 cm electronic plate. When we are applying a current (12 / (560 ohm/100)) = 2.14 A we will get approximately 25.68 watts, each resistor will affect the value of 0.2568W. So, the density heat of plate is 25w / 49cm^2 which is about ½ w / cm^2. In addition they are in parallel because the input volts will be the same on each resistor. Maximum input voltage is 12 DC, which will generate output power for each resistor about 0.250 W.

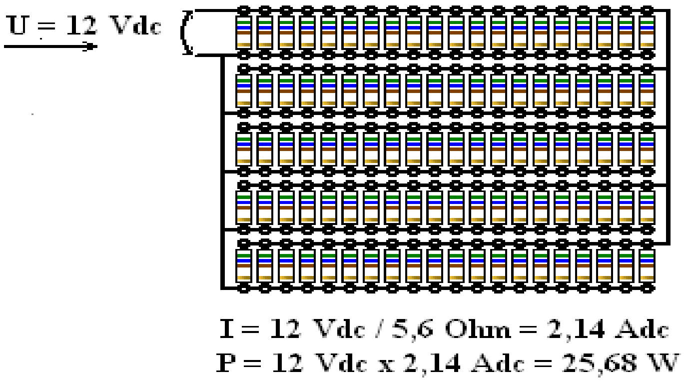


Figure 8: Illustration picture of the artificial processor

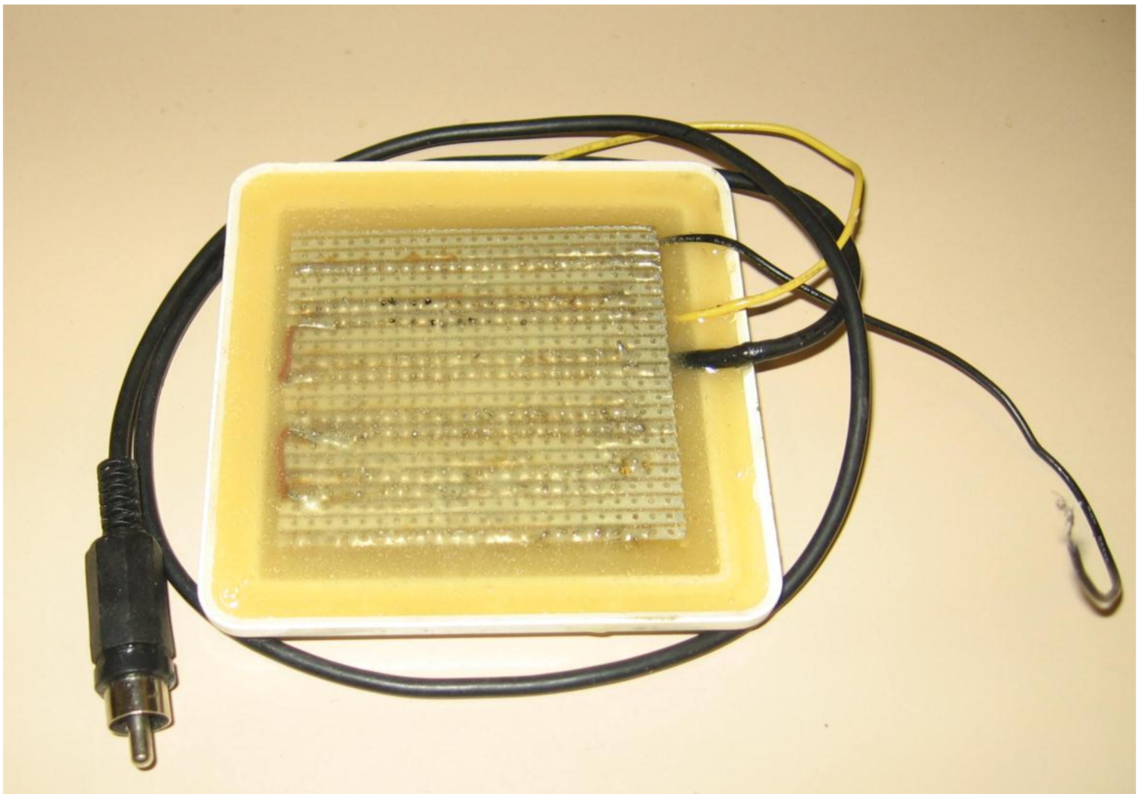


Figure 9: Bottom side of the artificial processor

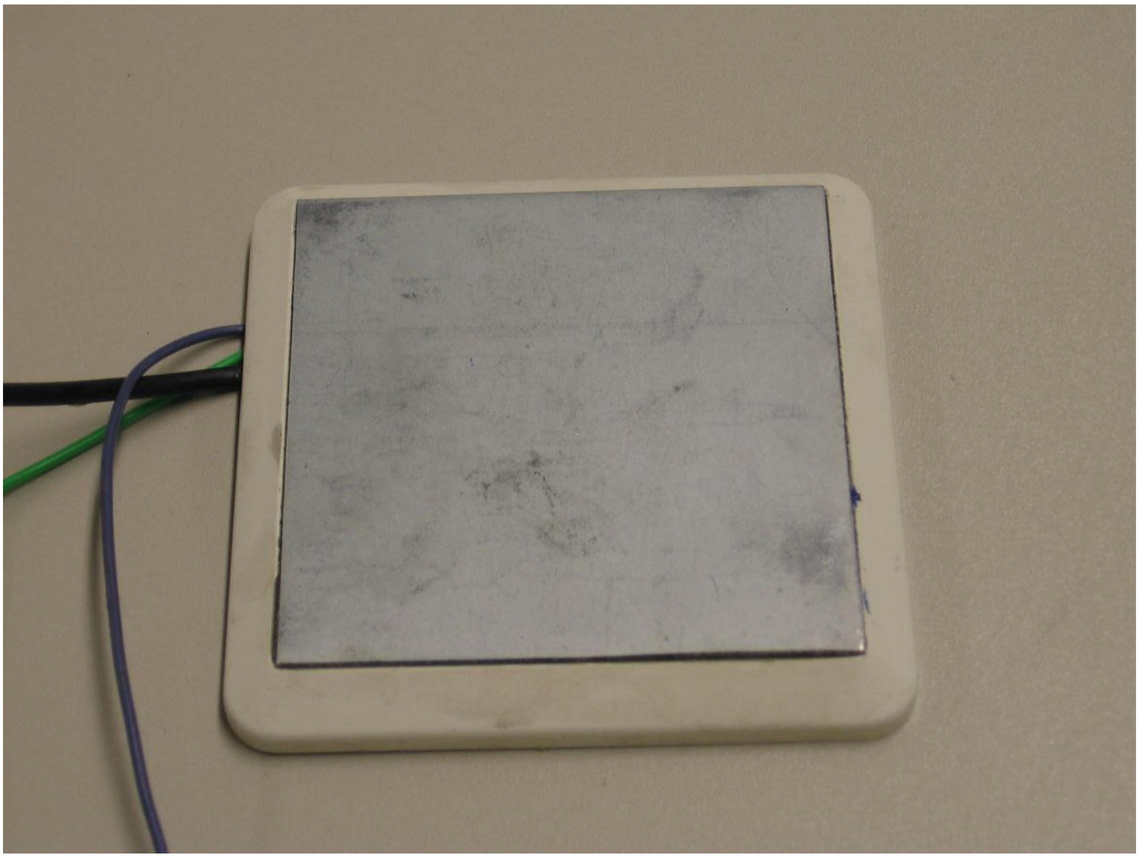


Figure10: Top side of the artificial processor

We have two versions of the artificial processor. The first one without a temperature sensor is used with a humidity simulation device to create heat. The second one is integrated in a temperature sensor used for temperature measurements and heat transfer, so we can measure precisely its temperature.

2.2.6 Additional fans with a heat sink

The components which produce heat and are susceptible to performance loss and damage include integrated circuits such as CPUs, chip and graphics cards. Overheated parts fail quickly and may give sporadic problems resulting in system freezes or crashes. To solve this problem, a fan and a heat sink are required. We are using these devices for many purposes, for passive heat sink cooling, active heat sink cooling, peltier cooling or thermoelectric cooling, also to produce pressure and noise pollution. In the labs we are using fans and the heat sink as follows:

- Two fans for a desktop computer (Figure 11) in addition to the own fan of the processor and power supply. The fan can create pressure and noise inside the computer's case.

- One fan and two heat sinks for a Humidity simulation device.(Figures 12)

Figure 11: Fans inside the computer’s case

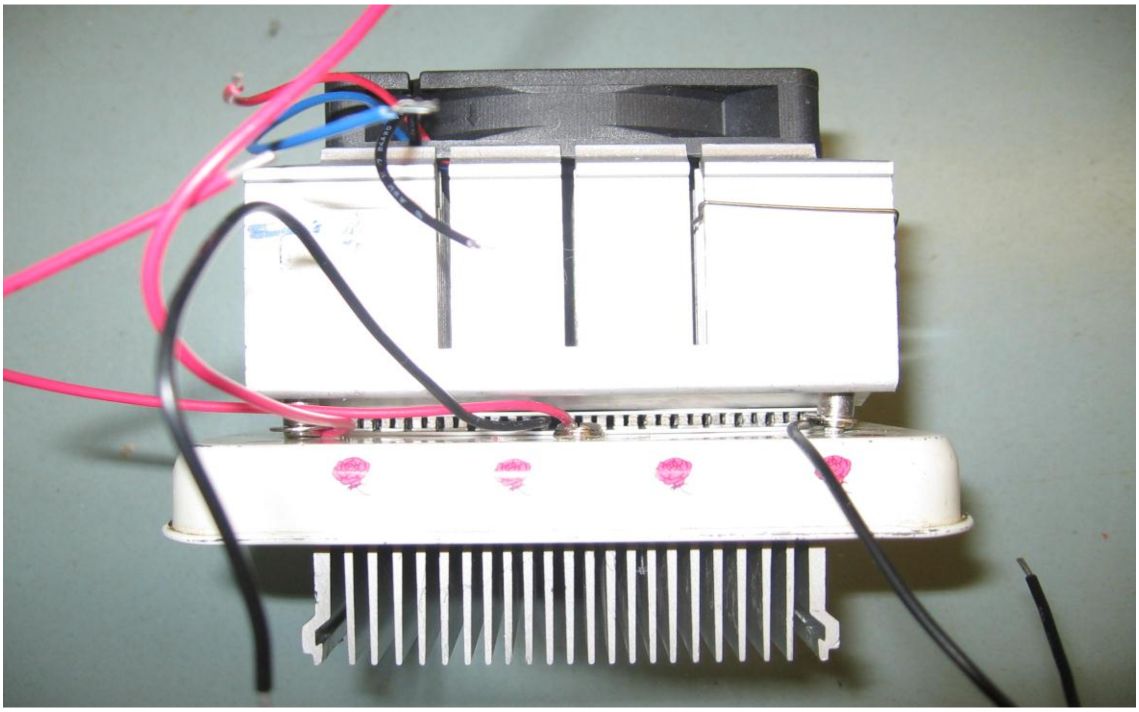


Figure 12: Fan with two heat sinks

2.2.7 U-Tube Manometer

A U-Tube manometer is made from glass in the form of a U-character consisting of a vertical column of liquid in a tube whose ends are exposed to different pressures. The column will rise or fall until its weight is in equilibrium with the pressure differential between the two ends of the tube. This device will show us the pressure and the temperature differential between the inside of the computer's case and the outside (room).

Also, we have another version of the U-Tube Manometer made from plastic material that is easier to use than the glass type.

The length is about 20 cm and the diameter is 5mm. (Figure 13)

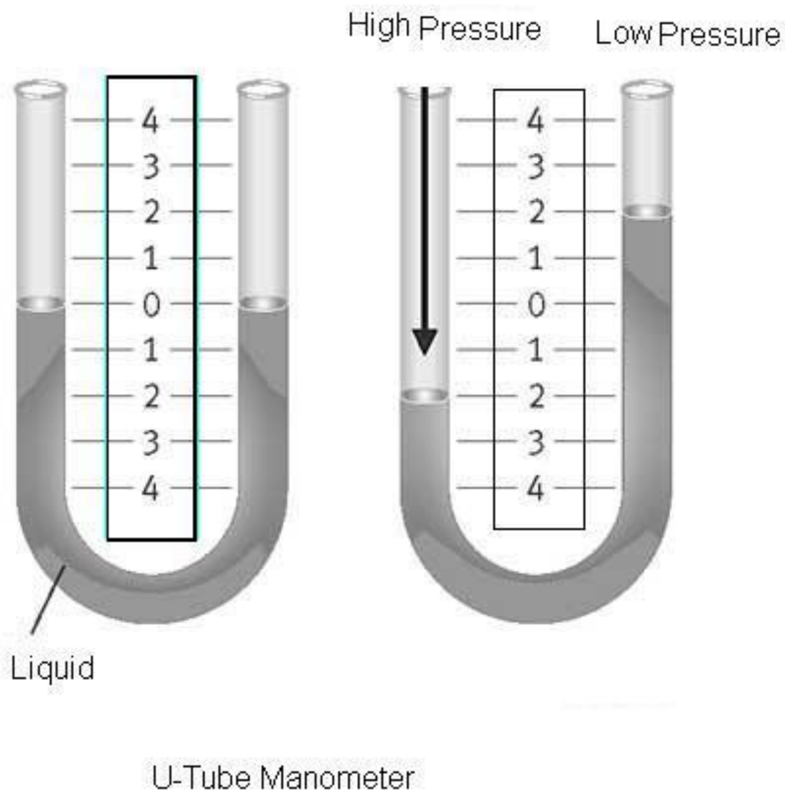


Figure 13: Illustration picture for a U-Tube Manometer

2.2.8 Humidity simulation device

This device is created by Markku Höglund (Figure 15). The idea consists of a closed box of metal with a cover. The negative side (or cold side) of the peltier cooling (or thermoelectric cooling) is fixed over the cover in the inner direction of the box while the positive side (or the hot side) of the peltier cooling is in the opposite direction. So a heat sink with a fan is fixed over the hot side of the peltier while only a heat sink is fixed under the cold side. A heat maker element, such as an artificial processor is fixed to the bottom of an empty box. A moisture measurement device is fixed to the middle of the box. In below and opposite direction of the moisture measurement device, there are two electrical sockets that connect all electrical devices to them. They are also connected to the power source which will provide them the electricity.

The specifications of the elements are:
Peltier:
Length = 4 cm, Width = 4 cm, height = 4mm
Fan:
Length = 7 cm, Width = 7cm, height = 1.5cm
Heat sink:
Length = 8.7 cm, Width = 7.5 cm, height = 4.4cm
Box:
Length = 10 cm, Width = 10 cm, height = 17.5m

So the sum of the height is 23.8 cm

The purpose of this device is to create simulation events that can happen inside the computer case during the physical changes of the temperature and cooling system. The picture below shows the construction of this device: (Figure 14)

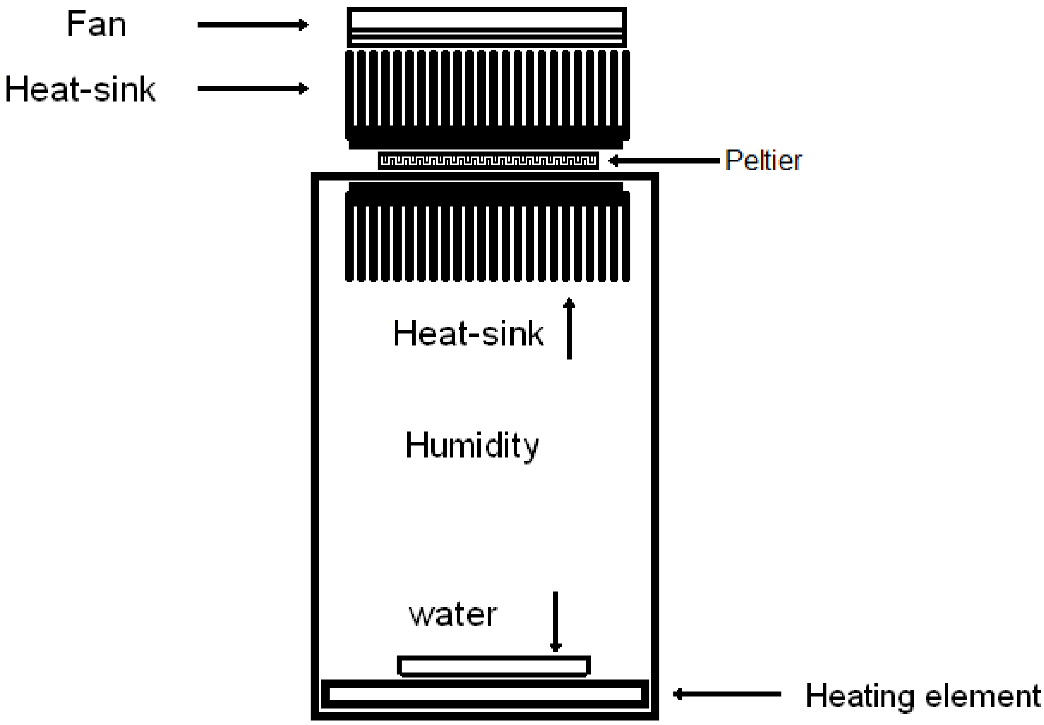


Figure 14: Humidity simulation device form

Figure 15: Stages of device construction

2.3. Audio Electronics

The meaning of this large domain is to present the problems that can be related to our labs, such as a noise and an acoustic short circuit. There are many types of noise such as an audio noise, an electronic noise and a visual noise. As we are working with electronics elements, the electronic noise exists in all circuits and devices as a result of the thermal noise. The reason for that is that there are random variations in the current or voltage always created in all circuits by the random movement of electrons which are vibrating around by the thermal energy. In the test we will focus on the sound noise and the acoustic short circuit by using a digital sound level meter device.

2.3.1 Noise pollution measurement device

The DVM1326 digital sound level meter can be used for sound level measurements e.g. in factories, schools, offices, airports. It can also check the acoustics of studios, auditoriums and hi-

fi installations. (Figure 16)

Figure 16: DVM1326 digital sound level meter

Features

- Two operating modes
- A & C weighting
- High (65 to 130dB) and low (35 to 100dB) measuring ranges
- 0.1dB resolution
- Fast/slow response
- Data-hold and max-hold functions
- Large 3 ½-digit LC display with function indication
- Built-in calibration circuit (94dB)

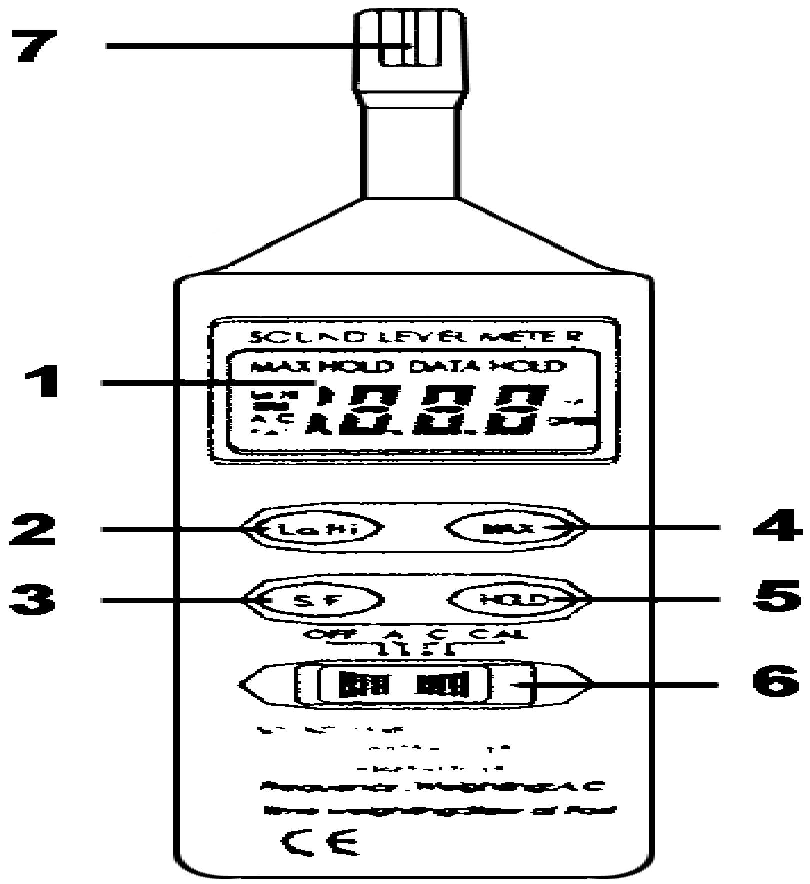
Specifications

Display	with functions dB, A & dB, C & dB, Lo & dB, Hi & dB and MAX HOLD, DATA HOLD indication
Max. Display	1999
Polarity	automatic negative (-) polarity indication
Overrange Indication	“OL”
Low-Battery Indication	“BAT” is displayed when the battery voltage drops below operating level
Measurement Rate	1.5/second (nominal)
Storage Temperature	-10 to +60°C (14 to 140°F) with RH < 80%
Power Supply	one 9V-battery (NEDA 1604 or 6F22)
Dimensions (H x W x D)	251 x 64 x 40
Weight	250g
Measurement Range	A LO (low) – Weighting: 35 – 10dB A HI (high) – Weighting: 65 – 130dB C LO (low) – Weighting: 35 – 100dB C HI (high) – Weighting: 65 – 130dB
Resolution	0.1dB
Typical Frequency Range	30Hz – 10 KHz
Frequency Weighting	A & C
Time weighting	fast
Accuracy	± 3.5dB at 94dB, 1 KHz sine wave
Microphone	built-in electret condenser microphone

Front Panel Description

1. LC display: 3 ½-digit LC display with dB, A, C, Lo, Hi, BAT, MAX HOLD & DATA HOLD indication
2. Low/Hi button: to select the higher or lower measuring ranges
3. S/F button: to select slow or fast response
4. MAX. HOLD: Press this button to hold the highest reading. Press the button again to release it and allow further measurements
5. DATA HOLD: Press this button to hold the current measurement. Press it again to release it and allow further measurements.
6. Function switch: to select the various measurement functions

7. Built-in electric condenser microphone



(Figure 17 From DVM1326 Digital Sound Level Meter user instructions, (No year of Publication), 2)

Figure 17: Front Panel

Operating Instructions

1. Place the function switch in the A or C position.
2. Hold the meter horizontally and direct the microphone towards the sound source to be measured.
3. Press the Lo/Hi button to select Lo & dB or Hi & dB.
4. Press the S/F button to select slow & dB or fast & dB
5. Both the A & C weighting curves have a frequency range between 30Hz and 10 KHz.
6. The fast response is ideal to measure short bursts of sound and peak values.
7. The sound level is displayed

Note: strong winds (> 10m/sec.) can influence your measurements. Use the included windscreen when this happens. (DVM1326 Digital Sound Level Meter user instructions, (No year of Publication), 1-2)

3 DEFINITION

The laboratory environments for the PC technology and device design in our system are created to do functions together. So, each lab was related to the PC technology and there is a device designed for its purpose.

3.1 Temperature measurements and heat transfer

The temperature measurements in this lab are divided into two sections:

3.1.1 Temperature measurement in the computer's case

In this lab the idea is to demonstrate the possibility of computer's software to monitor the temperature measurements of the main elements that are leading to generate heat problems, such as a microprocessor or in cooling system such as a fan.
Some motherboards contain a BIOS setup utility program that has information on microprocessor's temperature and fan speed with controlling and utilization (on / off). (Figure 18)

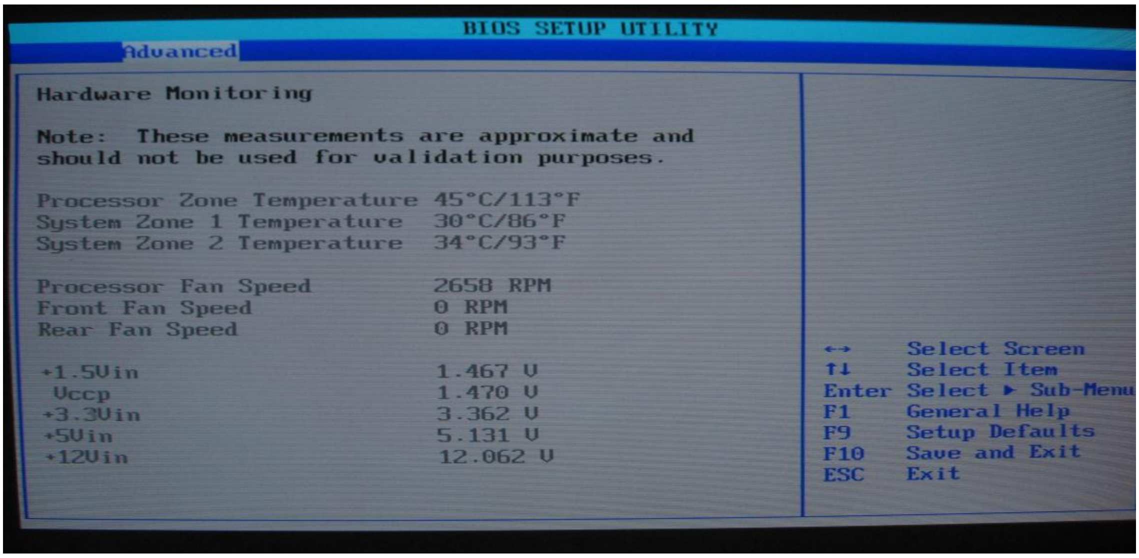


Figure 18: Temperature and Fan speed info in BIOS

In addition, some manufacturers provide free programs to monitor all main devices such as power, cooling and system information devices. Intel Active Monitor is a free program available from Intel Company which can monitor the system status by alerting users to some problems or effects occurring in the system. (Figure 19)

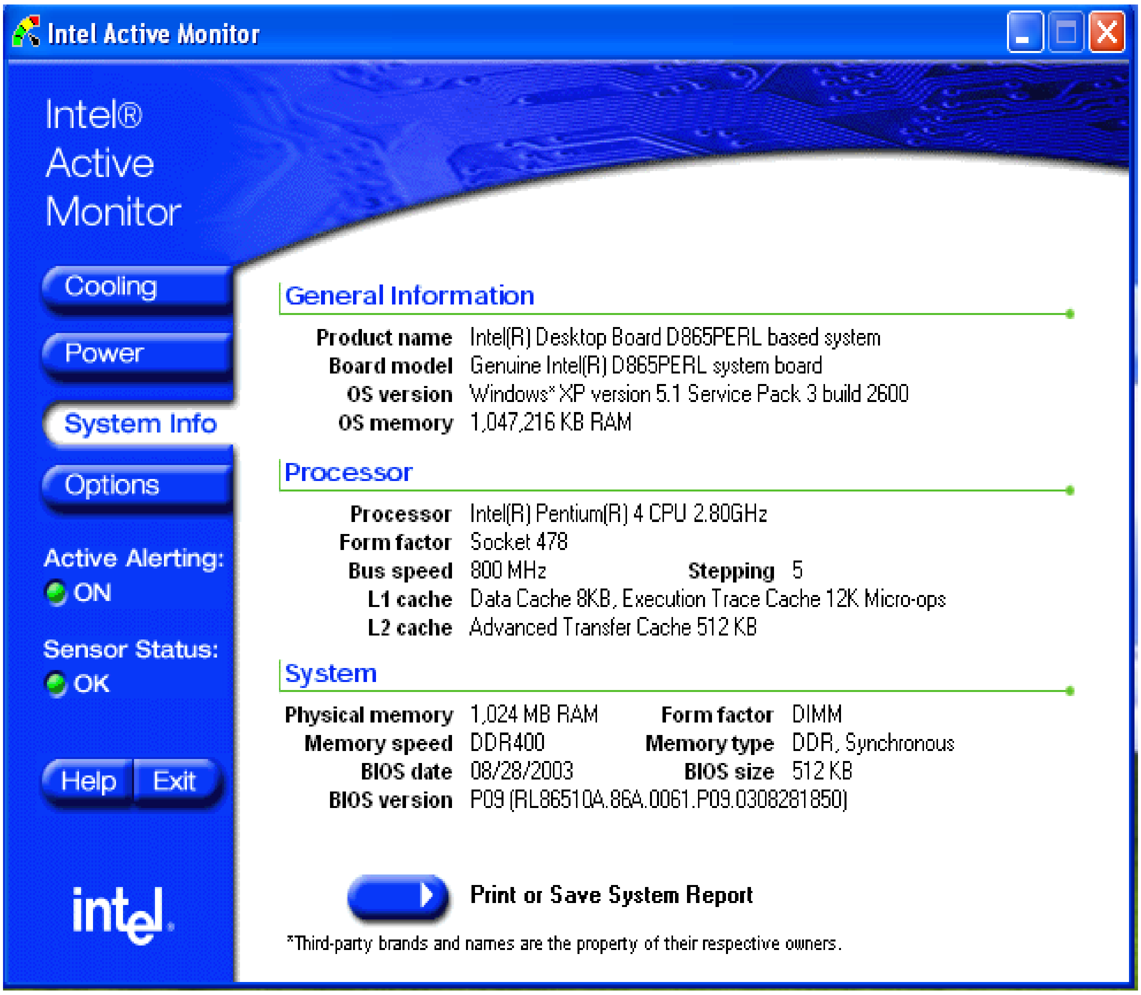


Figure 19: Intel Active Monitor Program

We can use a separate temperature measurement device to know the temperature for each element in a computer's case. This device is our temperature measurement device which is modified to be a portable device. We can install the sensors on the element where the temperature will be measured. By changing the channel on the required element in which the sensor is installed on, we will get the temperature results of the element.

3.1.2 Temperature measurements with the artificial processor

This lab refers to the temperature measurements occurring in the artificial processor to which the sensor is attached. At room temperature we will measure the artificial processor without a connection to any power source but with a connection to a digital temperature device which is powered on, we can connect the artificial processor to the voltage source of 12 volts and monitor the temperature rising every (30s) seconds. Then we will write down the values on the sheet or use any program, such as (Microsoft Office Excel), in the computer to save the results until the temperature reaches 100°C. This situation will demonstrate the temperature measurements without any device cooling. (Figure 20)

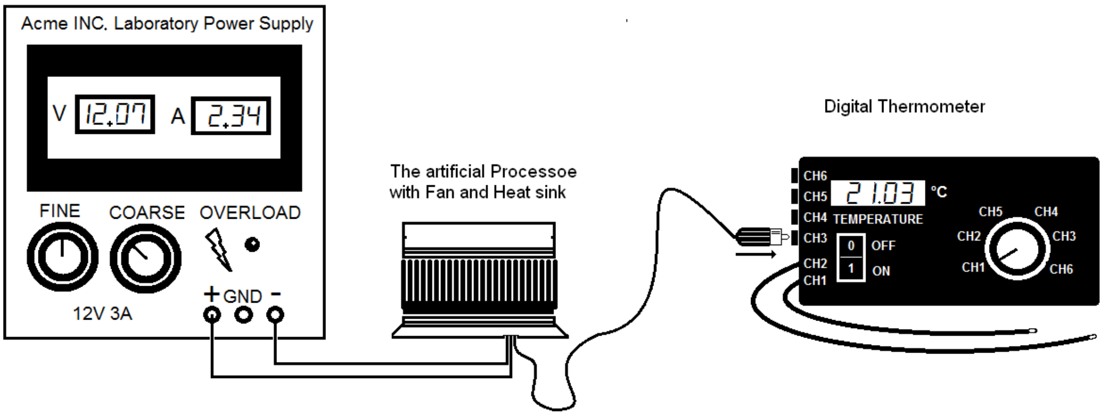


Figure 20: Temperature measurements with the artificial processor

3.2 Cooling

The aim of the computer cooling system is to set the computer's temperature at a stable condition as well as possible. For showing the cooling system changes caused by the heat, we established a cooling operation to view different cooling situations by using a digital temperature measurement device for the artificial processor. In addition, we used a heat sink and a fan.

3.2.1 Passive cooling

The artificial processor is connected to a voltage power source (12 volts). When the temperature reaches 100°C, the heat sink is installed directly on the top of the artificial processor. The values are recorded on the sheet or any program, such as (Microsoft Office Excel) is used in the computer every 30 seconds as the first situation in a new schedule until the temperature measurements do not indicate changes. In the cooling system, this operation including a heat sink without a fan is called a passive cooling. (Figure 21)

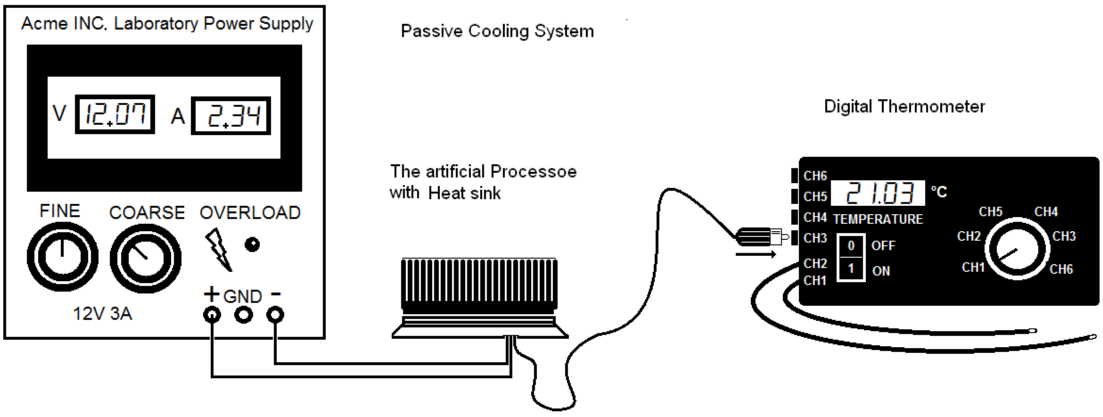


Figure 21: Illustration picture for passive cooling

3.2.2 Active cooling

Active cooling occurs when a fan is added on the top of the heat sink as in the previous situation. When the artificial processor temperature is at 100°C, the heat sink with a fan is installed on the top of the artificial processor and the results are recorded every 30 seconds as in the previous situation until a constant point of measurement is attained. (Figure 22)

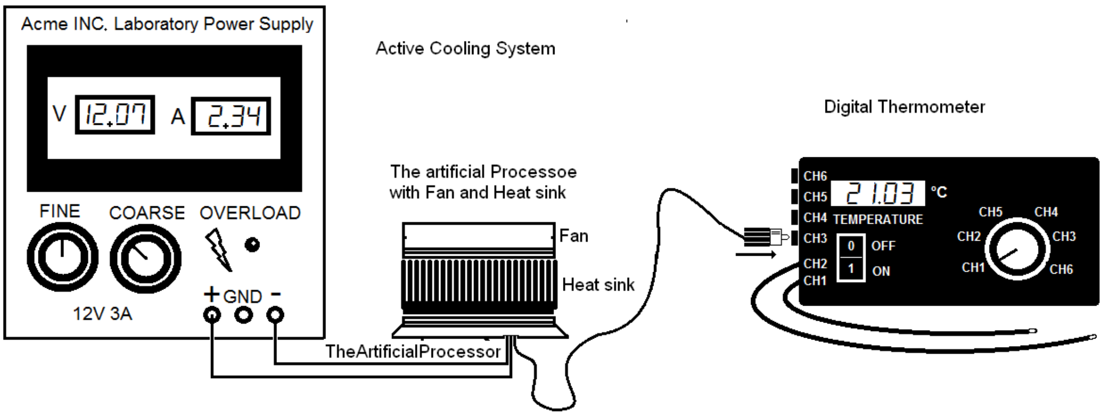


Figure 22: Illustration Picture for Active Cooling System

3.2.3 Results comparison

Comparing the results between the different cooling methods will create some questions to students: why the passive cooling is better than no cooling at all? Why the fan will improve the situation? What is the difference between cooling options and what are their pros and cons?

3.3 Air flow effects and pressure measurements

Generally, the presence of any barrier in front of an air flow will hamper its movement. The finger protection of the fan will reduce the amount of air flow inside the computer's case. In addition, cables and other devices installed inside a limited space will affect the air circulation.
There are many air flow measurement devices, but in simplicity we know the difference of pressure between two points in the same area with a manometer, which demonstrates the difference of air flow in that space.

3.3.1 Air pressure measurement

This differs from air flow measurement, so that the air flow routes will be blocked. These routes are holes which allow air to pass out or inside the computer case. The function of the fan is to create a high or a low pressure by switching the power on or off to control the air flow.
Fans are connected to free sockets on the motherboard. Also we can get power from the power supply of the computer.

In the computer case when the fan is creating air inside the limited space, it will create a pressure (a forward pressure source), and this air has a mass. When this mass is moving through a confined area or space, it will reverse the pressure by exerting the moving mass. This will create a backpressure which can affect the air flow efficiency. The air around the moving air can be confined. That internal air is measured by a U-tube manometer manufactured from a glass or a plastic tube. This pressure is expressed on a scale of mm/H2O.
The scale is calibrated by adding water and adjusting the scale in the measured place. To improve the readability it is possible to add coloured water.
Setting the measurement to zero on both sides of the scale, it will illustrate the pressure difference between the inside and outside of the computer case.

The goal of this test is to understand fan's role to study the air currents and obstacles in pressure and also the cooling effect.

3.4 Dew point measurement

Knowing the temperature of the surrounding environment of electronic devices is the most important thing to prevent devices from damage and dangers. As we know if a dew exists on the

electronic circuit that will lead to a short circuit and damage the components of that circuit. To understand the purpose of this effect, we prepared a lab test which simulates this idea.
A humidity simulation device is used for this challenge to measure the dew point.

When we put some drops of water on the artificial processor, which is connected to the power source with a peltier element and a fan together, the drops of water will turn into water vapor caused by the high temperature of the artificial processor. Then, it will ascend to the top of the box, because on the top it is colder, because of the cooling system. That water vapor will turn to water again to fall on the bottom where the artificial processor is. So in this situation the dew point measurement device will indicate the dew point degree. (Figure 23, 24)

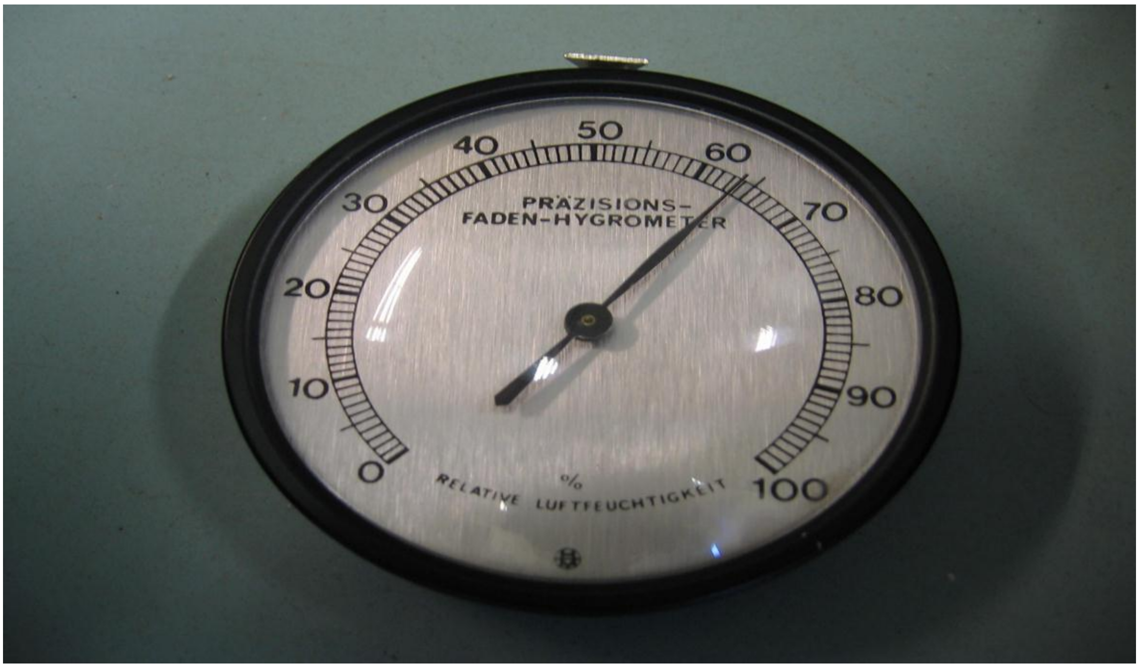


Figure 23: Dew point Measurement meter

Figure 24: Humidity simulation device

3.5 Noise pollution measurements

The noise pollution measurement focuses on computer background noise measurements. The measurements are carried out from four directions. The noise measure is done with an Hi/Lo set in position Lo and the emphasis switch is set to a point A. Decibels (dB) = $10 \log (P_2/P_1)$, which corresponds to the best measurement of a human hearing sense. During the measurement, the computer's BIOS setting change will be monitored and the noise levels setting will change in different operating mode. Operating modes can be an optimum mode, a performance mode and a silent mode. In addition, the noise pollution caused by a hard disk when the defragmenting program is turned on, can be measured, because of its uproar. Most of the computer noise pollution is caused by mechanical actuators such as fans and disk drives.

3.6 Acoustic short circuit

If we use a loudspeaker driver without a cabinet and a baffle, the sound will radiate on both sides of the driver. If the sine wave of sound moves in forward or in the direction of listener, it will compress the air in front of the driver, while the sine wave of sound will stretch it behind the driver. So at the rear, there is the rarefaction of the medium. This creates a phase difference of 180°. Considering low frequencies, the air around the driver can compensate the sound pressure difference, and the low frequencies are not radiated to the ambient environment. This cancelling out of sound is called acoustic short circuit. (Figure 25)

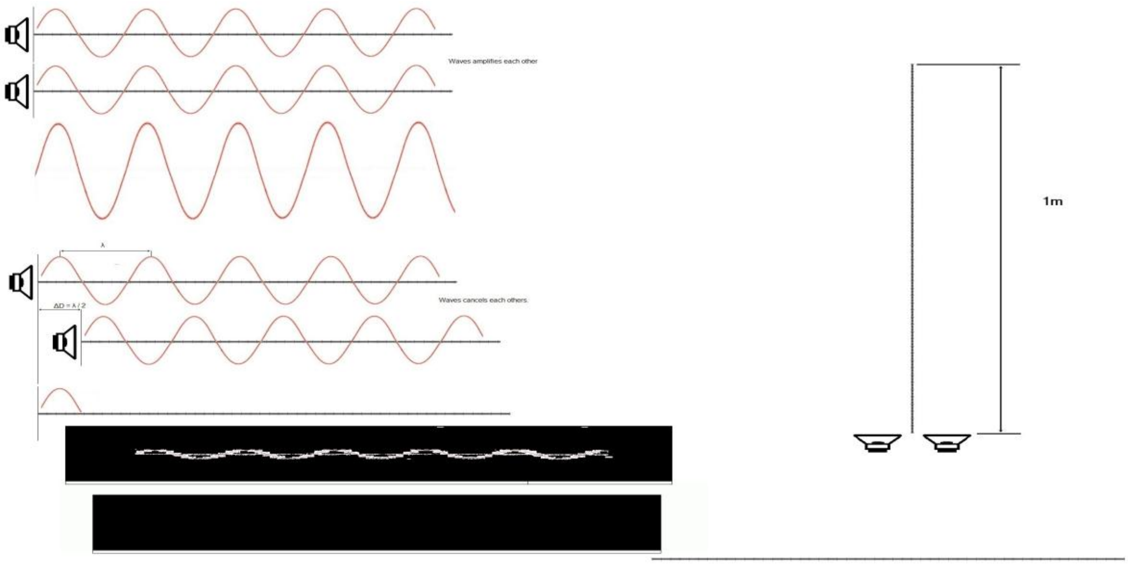


Figure 25: Illustration picture for Acoustic short-circuit

For example: If we have a distance between two sound phases (X2 –X1 = 30 Cm) as in figure below: [11] (Figure 26)

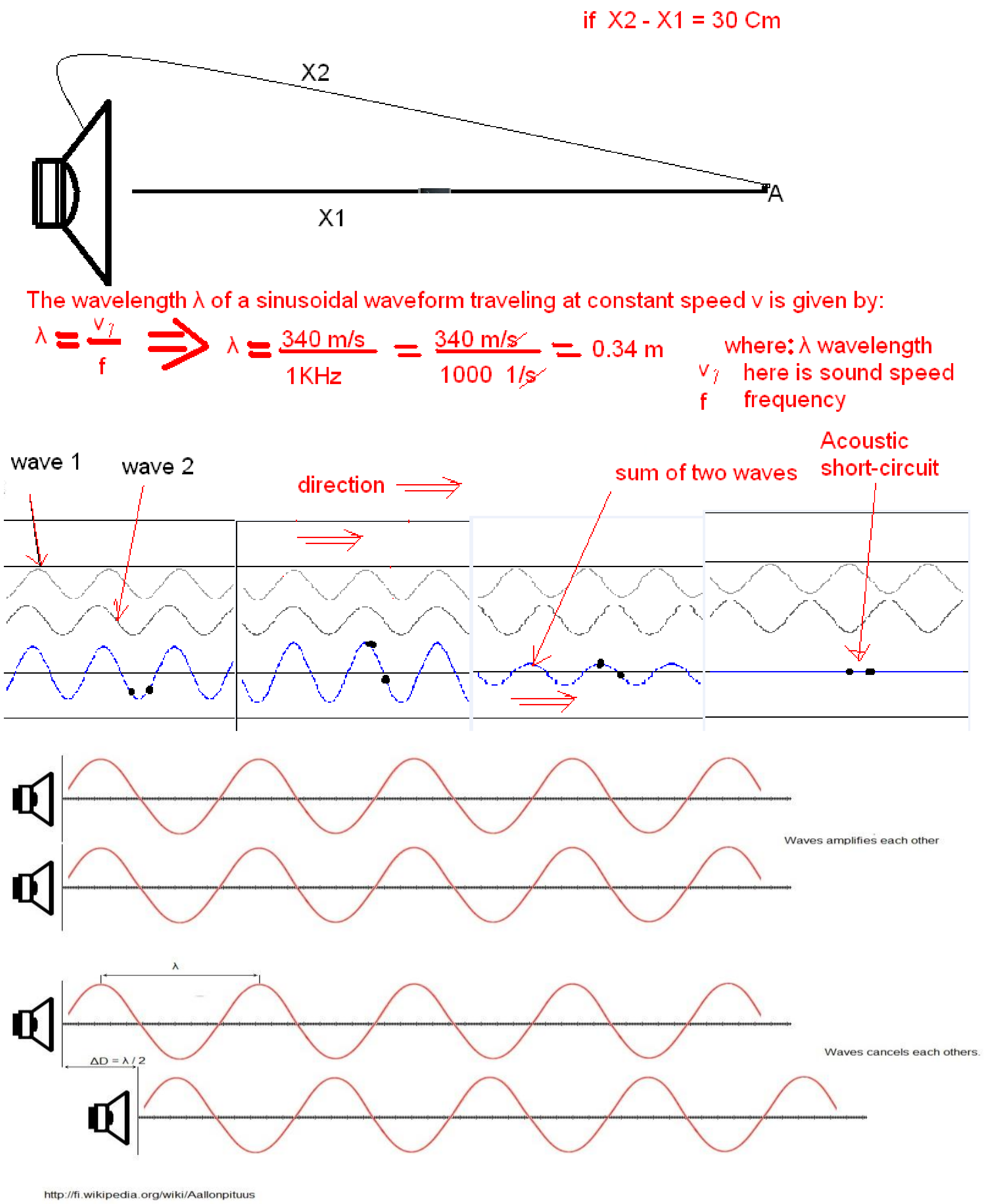


Figure 26: Distance between two sound phases

In this lab we are using audio software, such as Gold Wave 5.58, to create a two-mono channel sound, one of them is inverted. The computer speakers are turned against each other or they are faced in the same direction with a space about 100 cm between them. Students will observe how the selected channel phase shift (inversion) affects the sound. An audio editor program should be able to deal with stereo sounds. The sine wave is uploaded to two mono channels. A good sound frequency to be used is 444 hertz, but for a good test, a 1-kilo hertz is the best. A sound level meter device is put in the middle between the speakers to measure the decibels. (Figure 27)

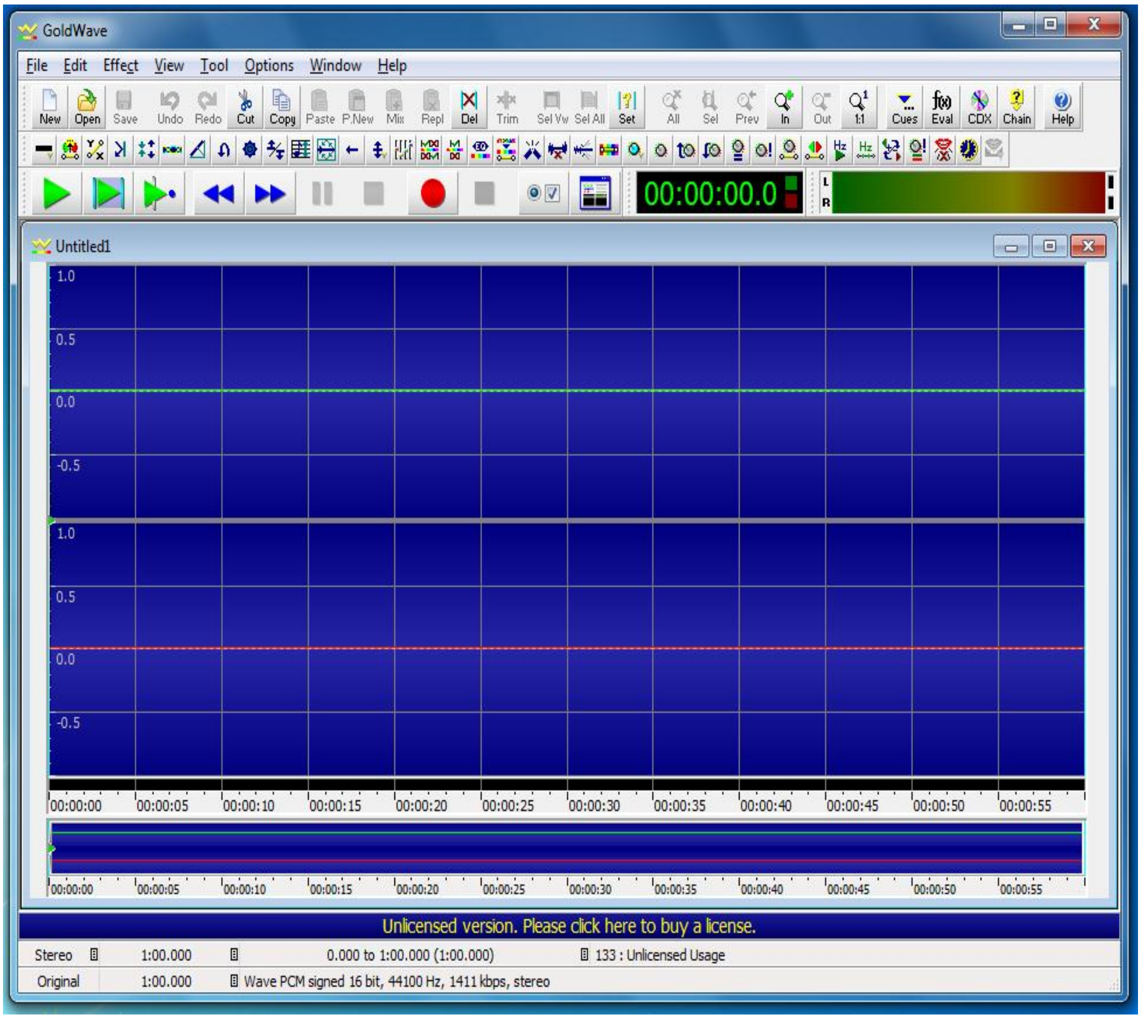


Figure 27: Gold Wave Program

4 IMPLEMENTATION

4.1 Temperature measurement by software

4.1.1 By BIOS program

On the laboratory's computer we applied all tests to implement the required functions.

The steps of the implementation in this lab are as follows:

1. Turn on the computer and press the function key F1 or delete to jump into a BIOS setup utility program. (Figure 28)

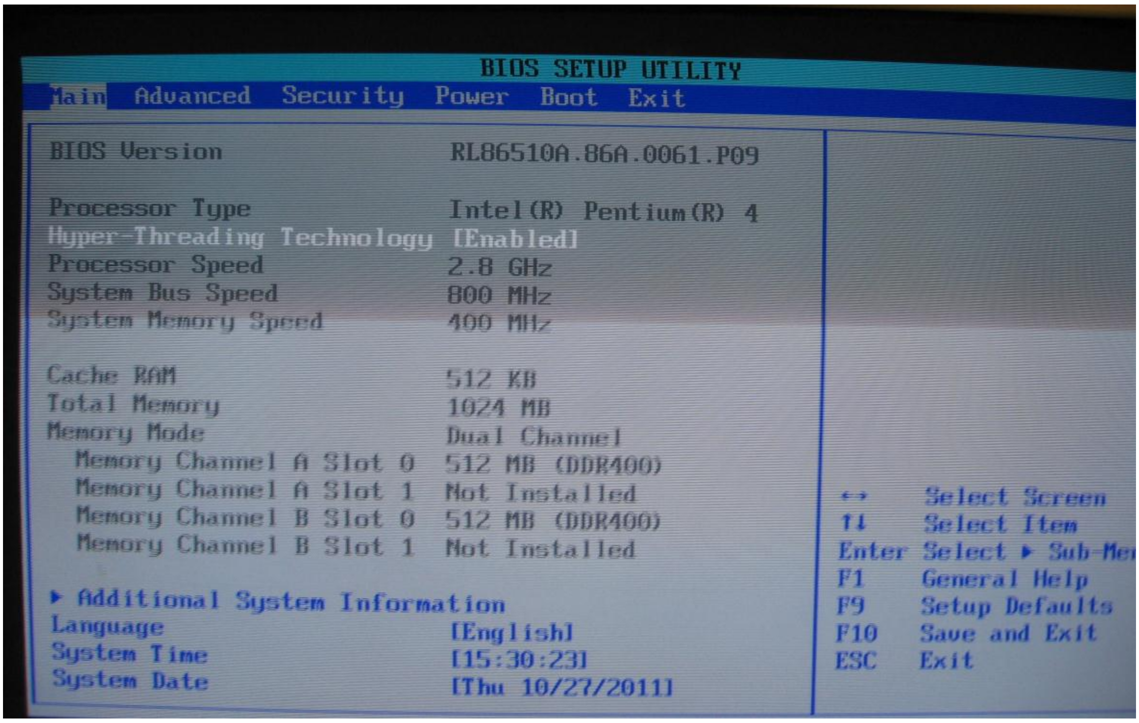


Figure 28: BIOS setup utility program

2. On the Main tab click the additional system information to get the system information as in figure below.(Figure 29)

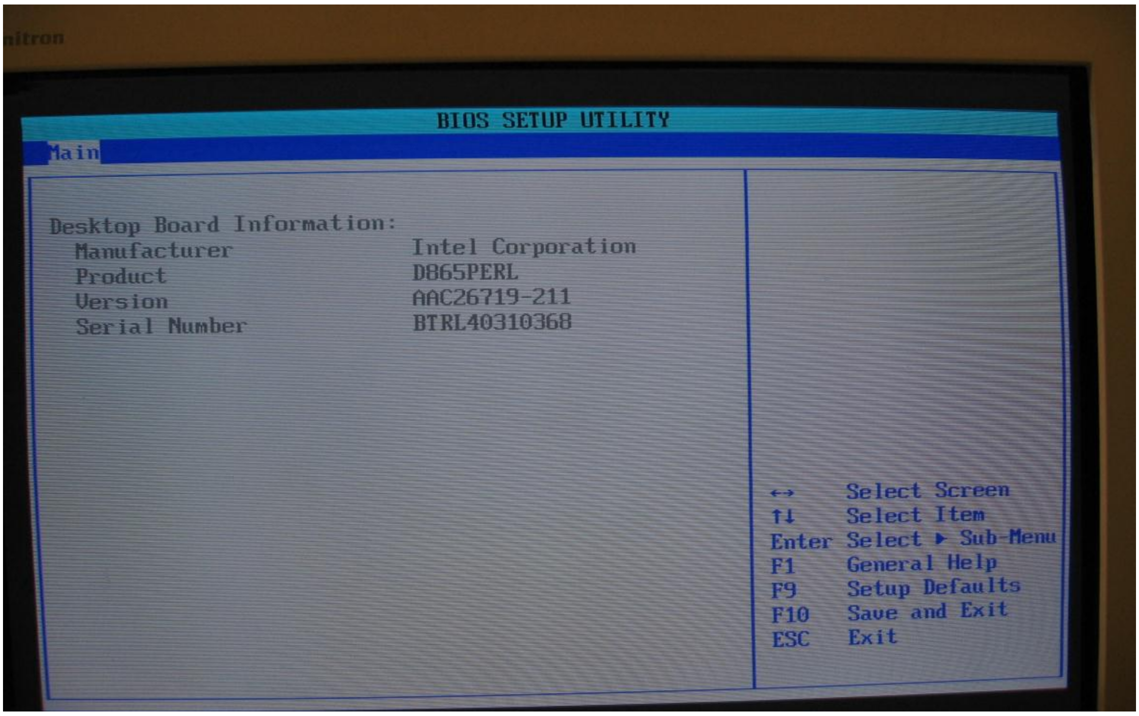


Figure 29: Desktop Board Information

3. On the advanced tab click the hardware monitoring to get information on the processor temperature and fan speed as shown in the figure below. (Figure 30)

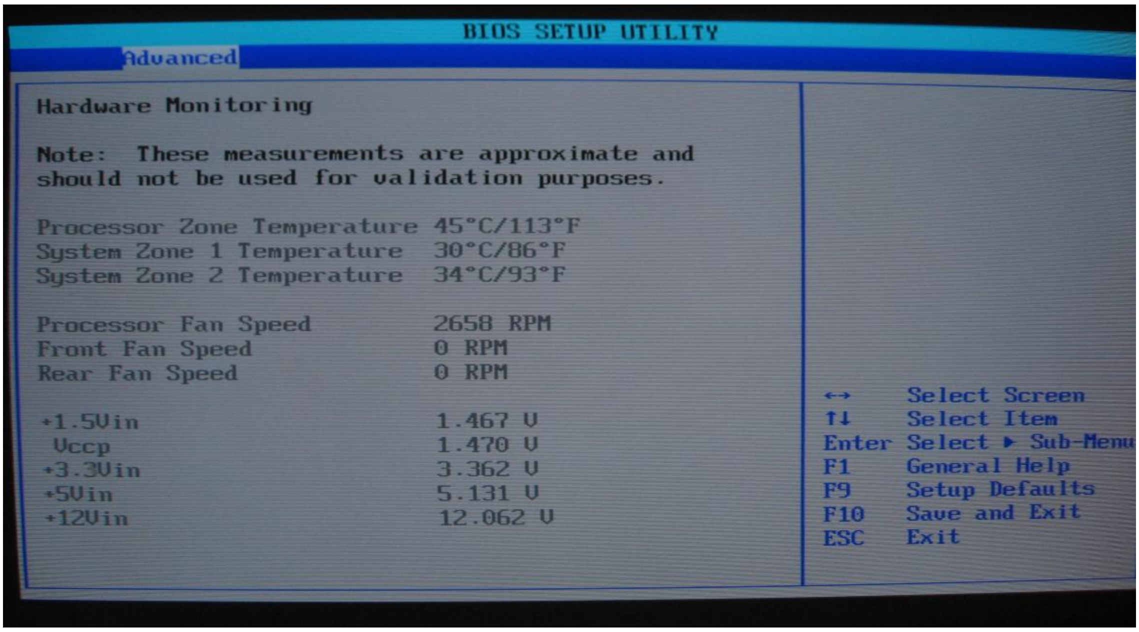


Figure 30: Hardware Monitoring

4.1.2 Intel Active Monitor program

To get the results about your hardware with this program you should install this program from the website of the manufacturer. After installation:

1. Click Start =>All programs => Intel Active Monitor
2. To know the temperature and fan speed, click the cooling tab as in the figure below.(Figure31)

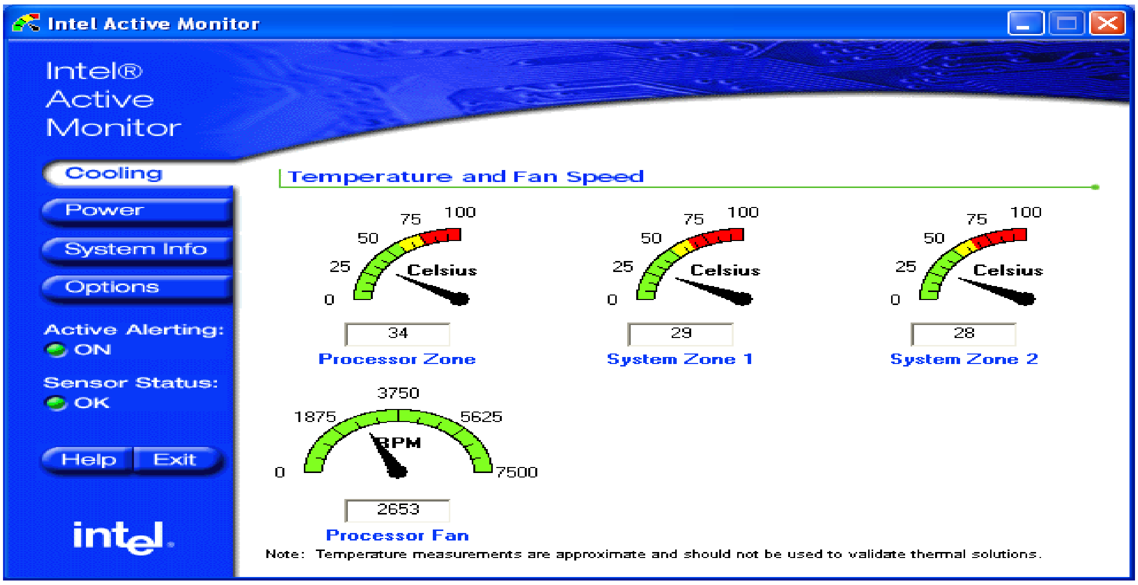


Figure 31: Temperature and Fan speed Monitoring

3. Click Power to get the information on the power supply voltage and CPU voltage. (Figure 32)

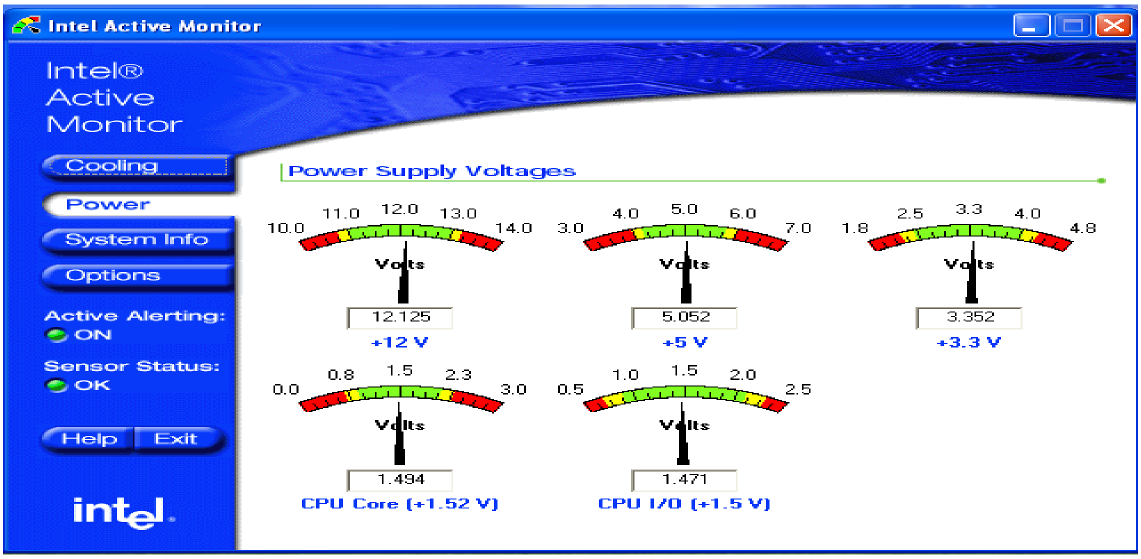


Figure 32: Power Supply Voltage Monitoring

4. Clicking the system info tab will show the computer system information. (Figure 33)

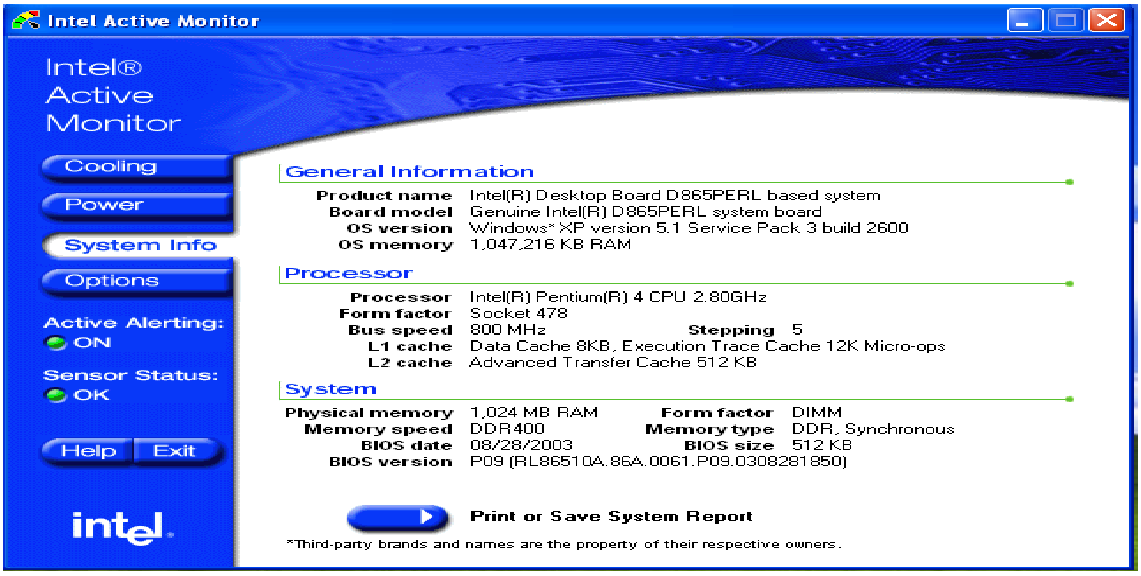


Figure 33: system Information by Intel Active Monitor

5. In options tab you can change settings such as active alerting options and set sensor thresholds as in the figure below. (Figure 34)

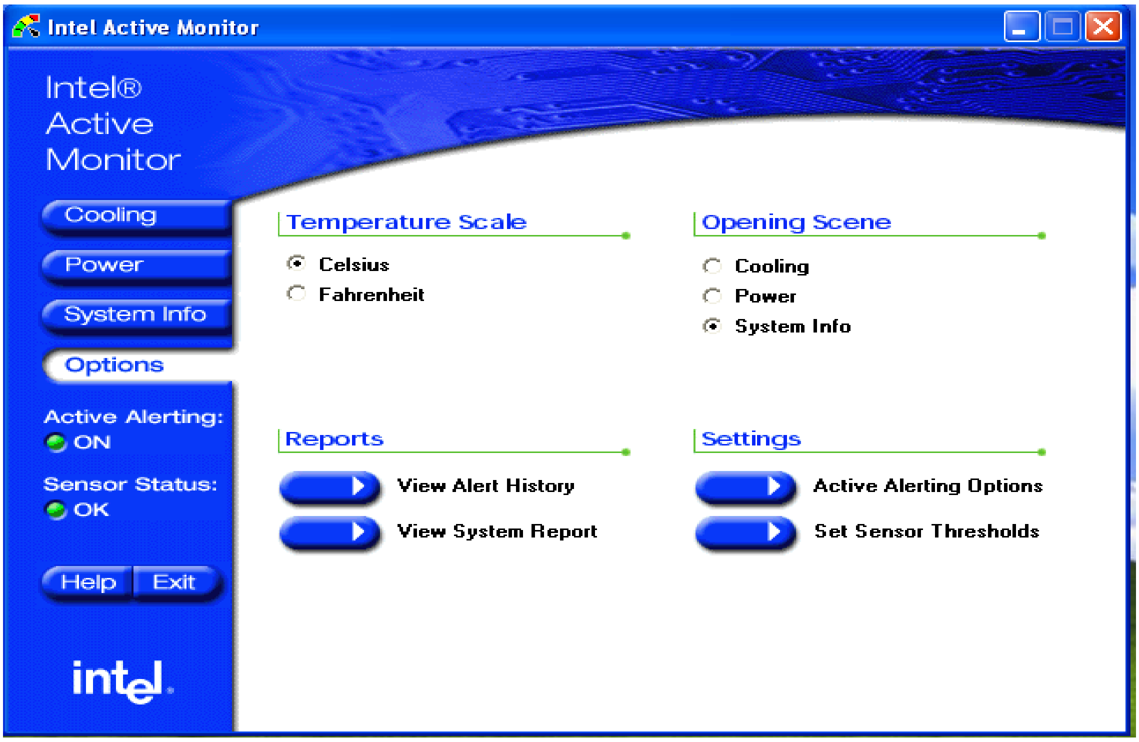


Figure 34: Options

4.2 Temperature measurement by a Digital Thermometer

With a portable temperature measurement device it is very easy to measure the temperature of any part of the computer hardware using these steps:

1. Install any sensor of the temperature device on the part of computer hardware or any place in computer case you want to be measured.
2. Connect the temperature device to a power source using its charger. Apply between 9 V to 12 V or use batteries between those values of volts.
3. Switch on the device and turn between channels to get the temperature of the required sensor.

4.3 Temperature measurements with the artificial processor

Equipment needed in this lab is:

1. Thermometer
2. Artificial processor with a sensor
3. Adjustable power supply (Min 12 V, 3 A), with voltage and current meters.
4. Wires

To create the test follows the following steps: (Figure 35)

1. Connect the thermometer to a power source and turn it on.
2. Connect the artificial processor' sensor with the thermometer.
3. Connect the artificial processor to the power source (12 V).
4. Adjust the channel to the artificial processor sensor channel.
5. Register the results on a paper or on any office program every 30 seconds.
6. Monitor the temperature rise until it reaches 100°C.

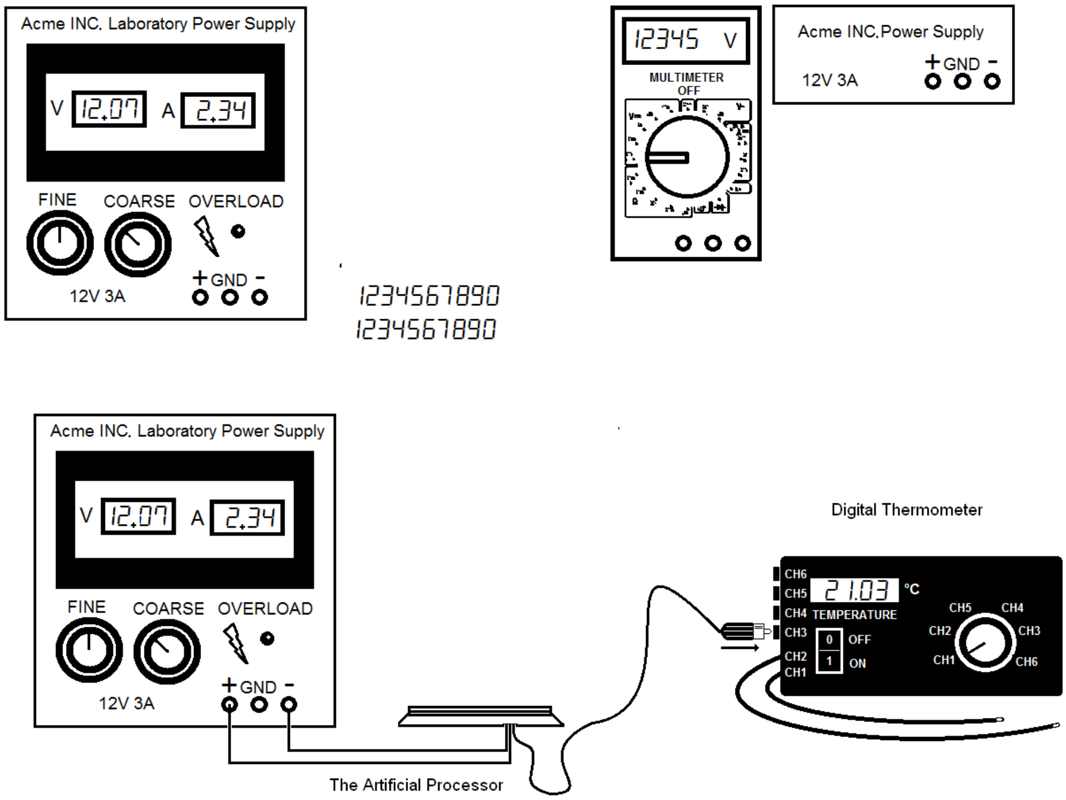


Figure 35: Illustration of Temperature measurement

4.4 Cooling

Equipment needed in this lab is: (Figure 36)

1. Thermometer
2. Artificial processor with a sensor
3. Adjustable power supply (Min 12 V, 2 A), with a voltage and current measure.
4. Wires
5. Heat sink
6. Fan

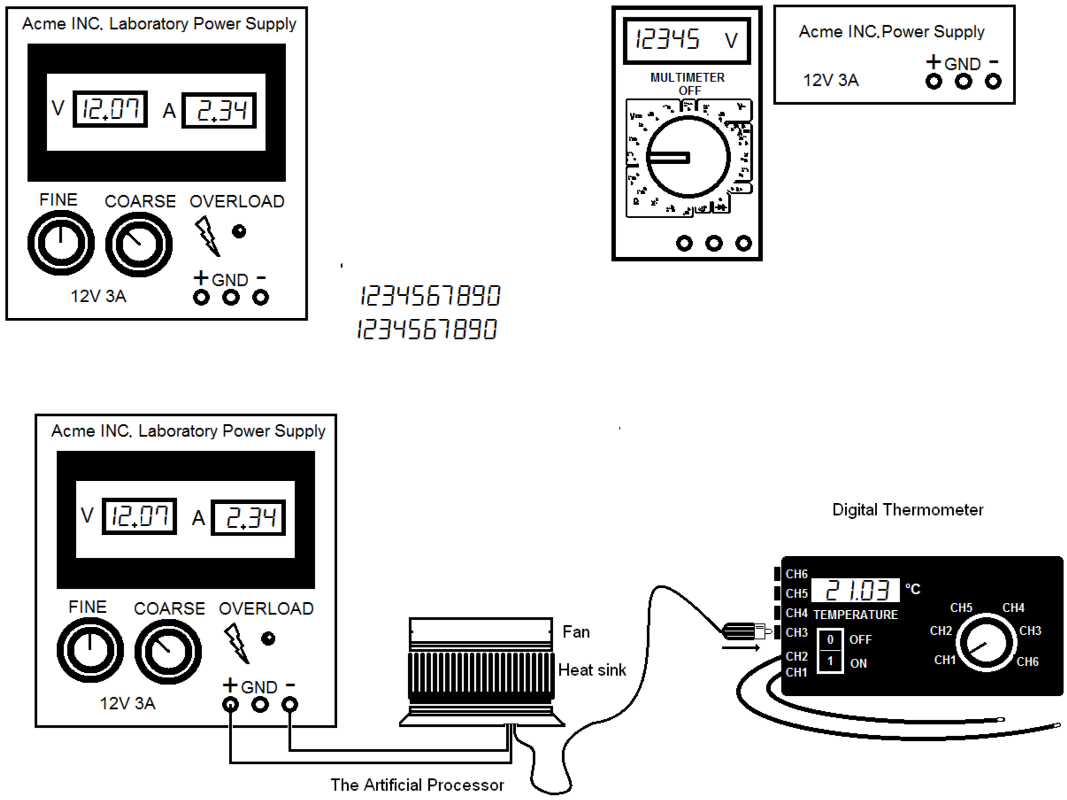


Figure 36: Illustration picture for cooling system

4.4.1 Passive cooling

To create the test, follow the following steps:

1. Connect the thermometer to a power source and turn it on.
2. Connect the artificial processor' sensor with the thermometer.
3. Connect the artificial processor to the power source (12 V).
4. Adjust the channel to the artificial processor sensor channel.
5. Monitor the temperature rise until it reaches 100°C.
6. At that degree install a heat sink directly over the artificial processor.
7. Register the results on a paper or on any office program every 30s seconds.
8. Note that the temperature has dropped down.

4.4.2 Active cooling

To create the test, follows the following steps:

1. Connect the thermometer to a power source and turn it on.
2. Connect the artificial processor' sensor with the thermometer.
3. Connect the artificial processor to the power source (12 V).
4. Adjust the channel to the artificial processor sensor channel.
5. Monitor the temperature rise until it reaches 100°C.
6. At that degree install directly over the artificial processor a heat sink with a fan connected to a power source (12 V).
7. Register the results on a paper or on any office program every 30 seconds.
8. Note that the temperature has dropped down faster than in the passive cooling case.

4.5 Air flow effects and pressure measurements

The equipment needed in this lab is:

1. A computer case with two flexible additional fans (easy to move their direction and place) connected to a motherboard or a power supply.
2. A modified computer case with a window made of Plexiglas (polymethyl methacrylate).
3. A U-Tube manometer attached to the computer case having one side inside the case and the other side outside the case. (Using a hole created to the Plexiglas).
4. An Intel active monitor program.

4.5.1 Air pressure measurement

1. Turn on the computer and start the Intel active monitor program.
2. Switch on the fans.
3. Monitor the changes of the water level in the U-Tube manometer, performing the cooling and power settings in the Intel active monitor program.
4. Switch the power between fans (on/ off) in different cases such as:
    1. Both fans are on.
    2. Both fans are off.
    3. One is on and the second is off.
    4. In the same case turn the directions of the fans and note what happens.

4.6 Dew point measurement

In this lab we are using a humidity simulation device with following steps:

1. Put a few water drops over the artificial processor (not too much).
2. Connect all devices (the artificial processor, peltier and fan) to power connection points.
3. Connect the humidity simulation device to a power source.
4. Wait for a while until physical changes occur, such as water changes to a water vapour as the temperature rises in the artificial processor, and monitor the dew point measurement pointer, which will show the dew point degree.

4.7 Noise pollution measurements

To measure the noise pollution you have to use a noise pollution measurement device, such as a DVM1326 digital sound level meter. The following are the steps for the noise pollution measurements:

1. Before starting, the computer should be off at least 30 minutes.
2. While the computer is off, measure the noise from four directions.
3. At the distance of one meter from the computer, point the decibel measurement towards the computer. (Figure 37)
4. Place the function switch to A or C position.
5. Hold the meter horizontally and direct the microphone towards the sound source to be measured (computer). Make sure that loud speakers are not attached to the computer.
6. Press the Lo/Hi button to select Lo & dB or Hi & dB.
7. Press the S/F button to select slow & dB or fast & dB
8. Both the A & C weighting curves have a frequency range between 30Hz and 10 KHz.
9. The fast response is ideal to measure short bursts of sound and peak values.
10. The sound level is displayed
11. Write values to a paper.
12. Turn the computer on and select optimum, performance and silent settings from bios.
13. Repeat measurements as stated above while the computer is not doing anything and write values to a paper.
14. Start using the software or defrag to create a load for the processor or hard disk and repeat measurements writing values to a paper.

Note: strong winds (> 10m/sec.) can influence your measurements. Use the included windscreen when this happens

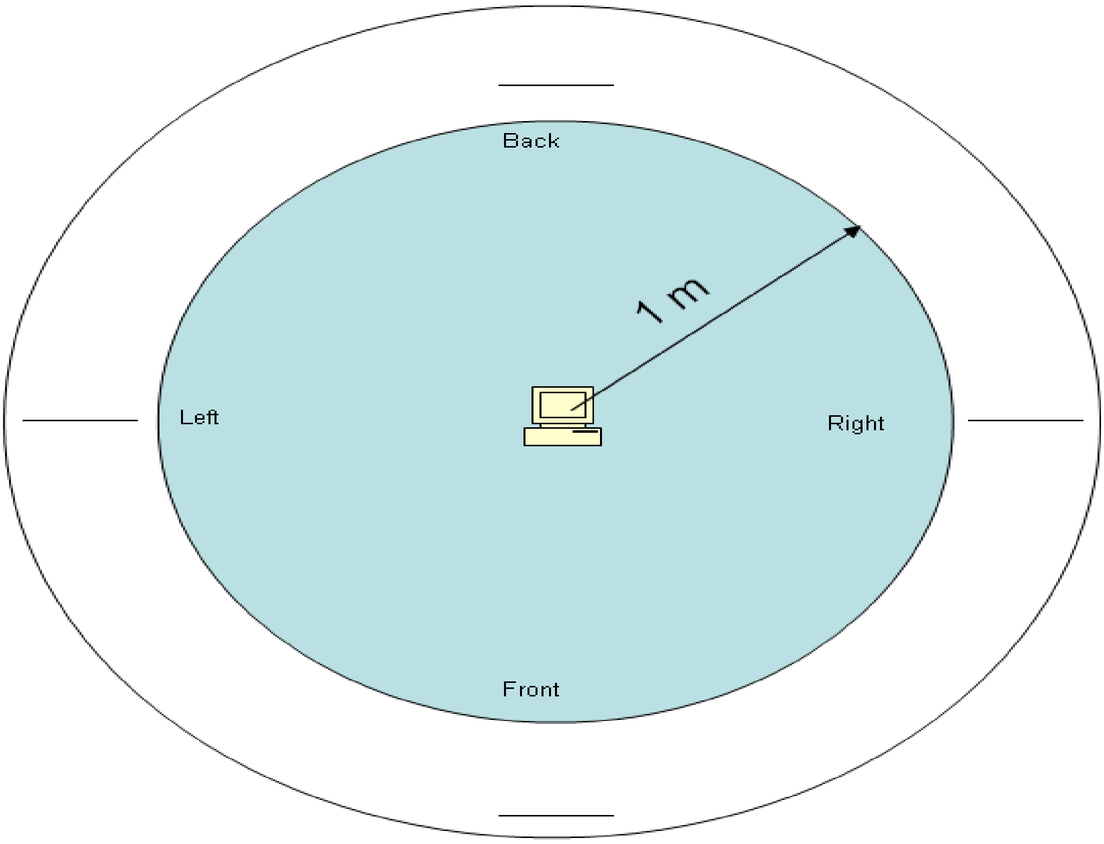


Figure 37: Room noise chart

4.8 Acoustic short circuit

For applying the test in this task, you should follow these steps:

1. Turn on the computer and start a gold wave program (Figure 38)

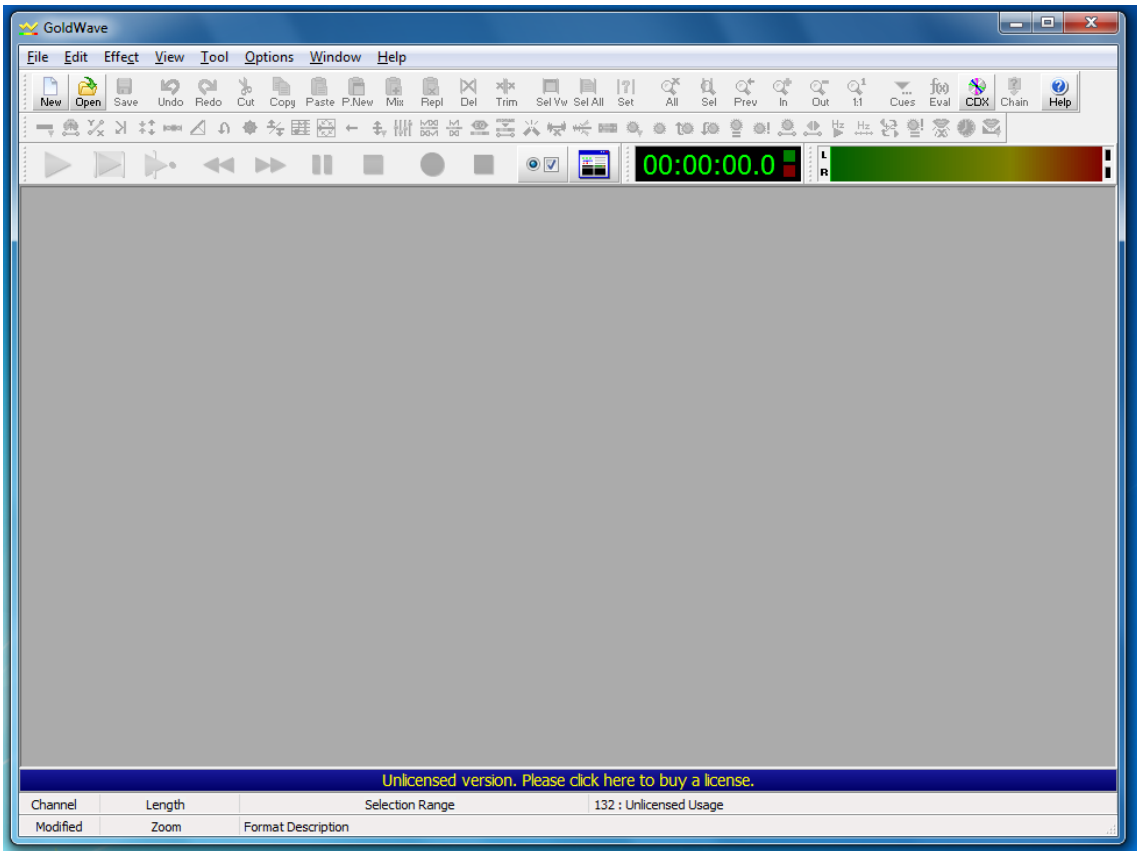


Figure 38: Step 1

2. Turn on computer loudspeakers and move them 100 cm from each other. Place them to face in opposite directions or place them to point in the same direction. In case the loudspeakers are pointing in the same direction, place one of them in front of the other in parallel. (Figure 39)

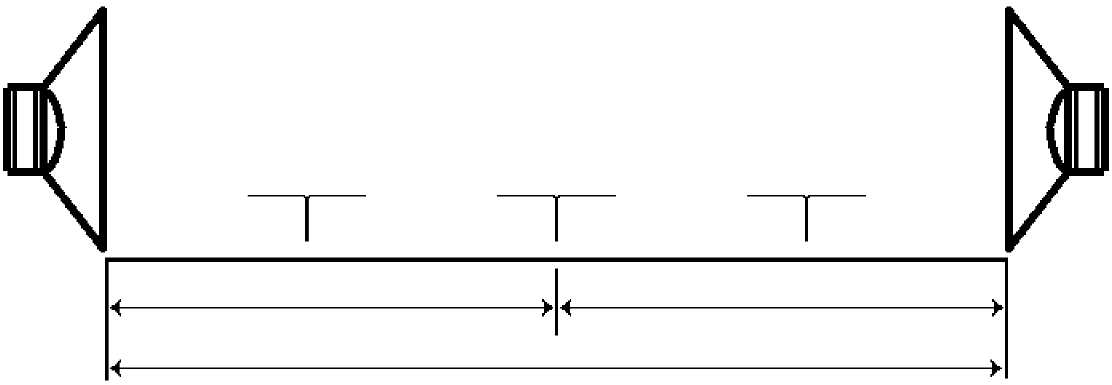


Figure 39: Step 2

3. Put a digital sound level meter in the middle between them. In case they face in opposite directions, or in a distance in front of them in the parallel case. (Figure 40)

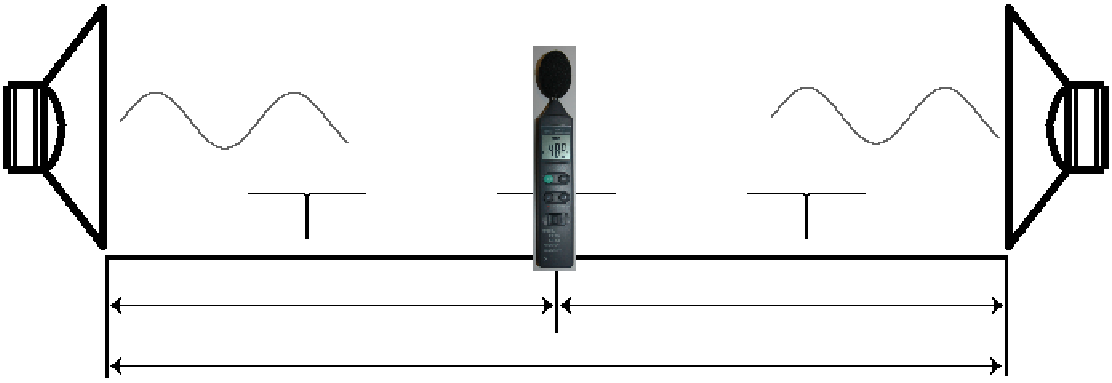


Figure 40: Step 3

4. Apply a sine wave of 1 KHz to the gold wave program as follows:
   1. Select a file => New. (Figure 41)

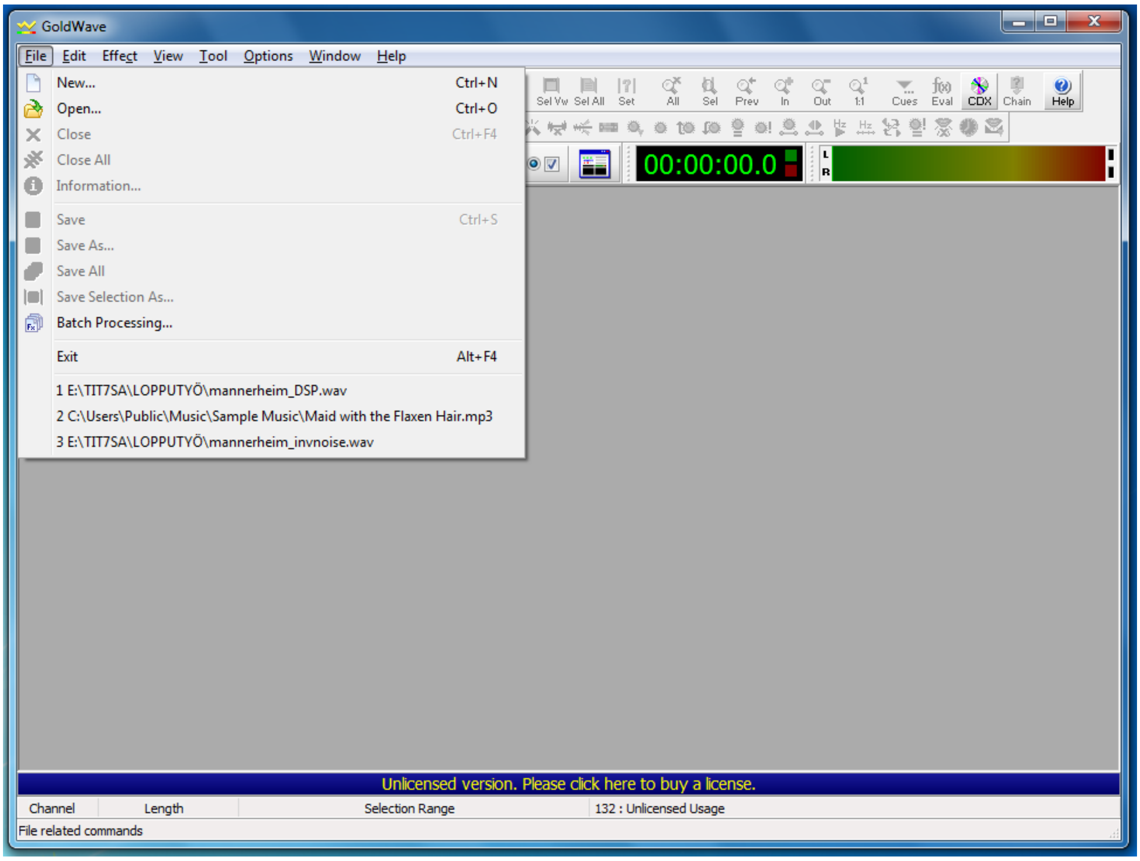


Figure 41: Step 4 -1

2. Select the number of channels, 2 (mono), the sampling rate 1 KHz and the file length 1 minute, then press OK. (Figure 42)

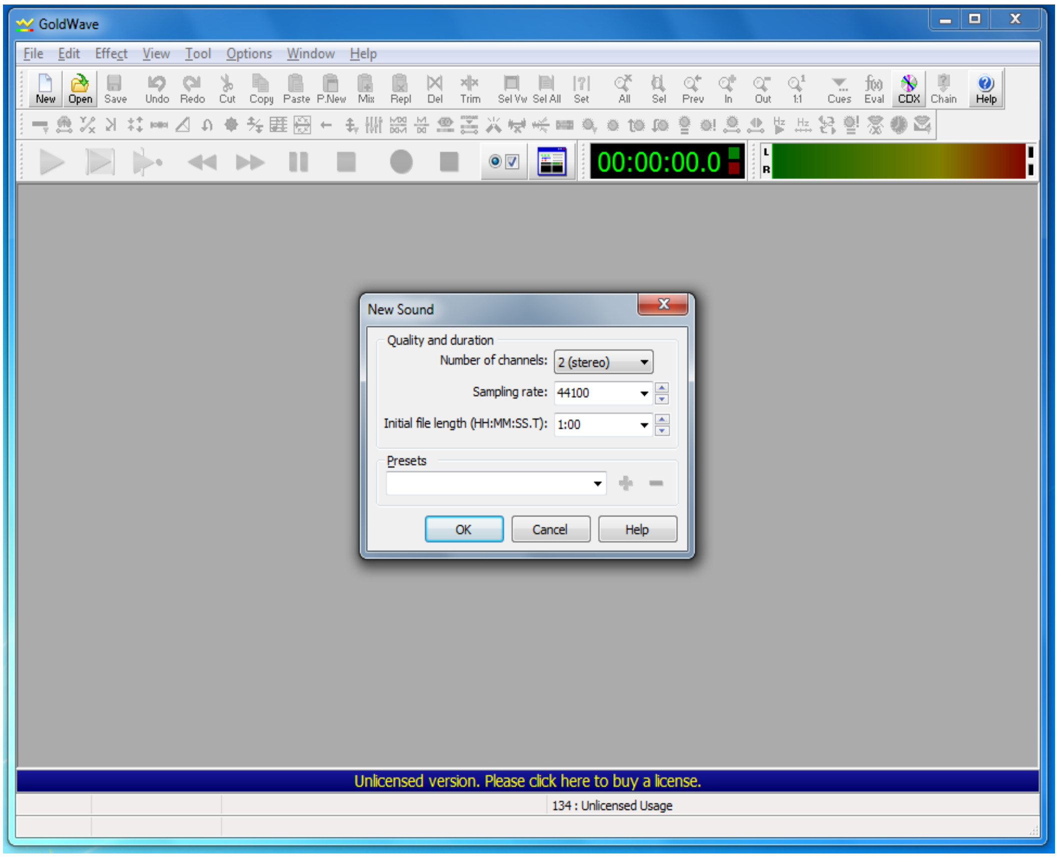


Figure 42: Step 4 -2

3. New wave window editor will appear. (Figure 43)

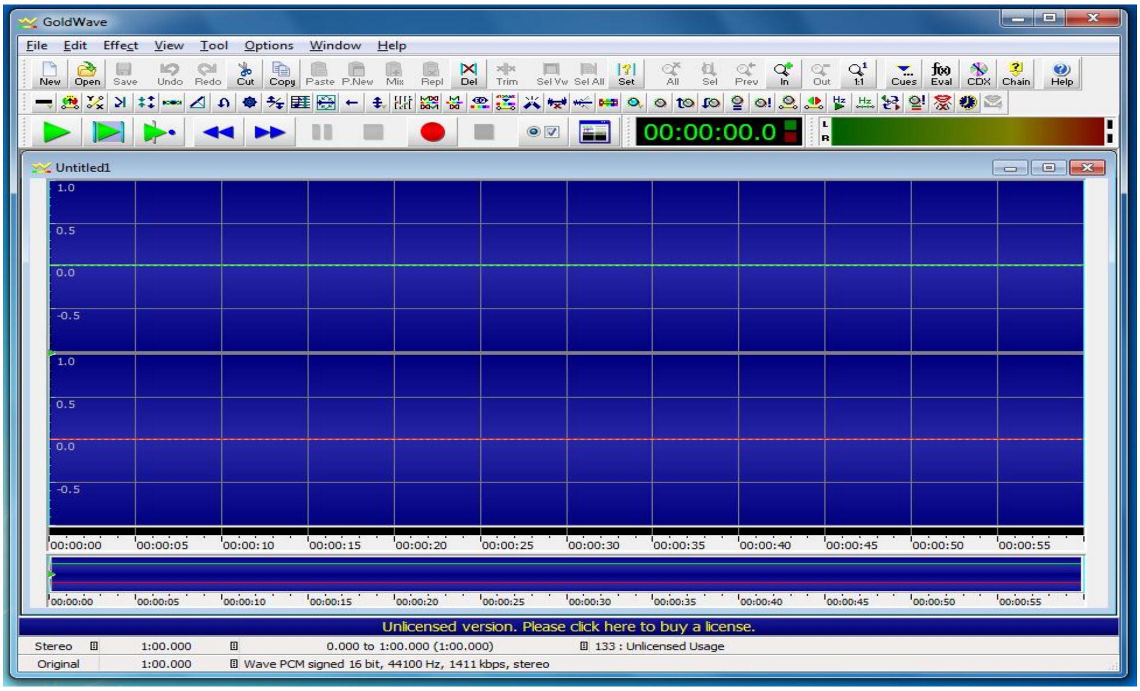


Figure 43: Step 4 - 3

4. Select in the Tool menu the Expression evaluator. (Figure 44)

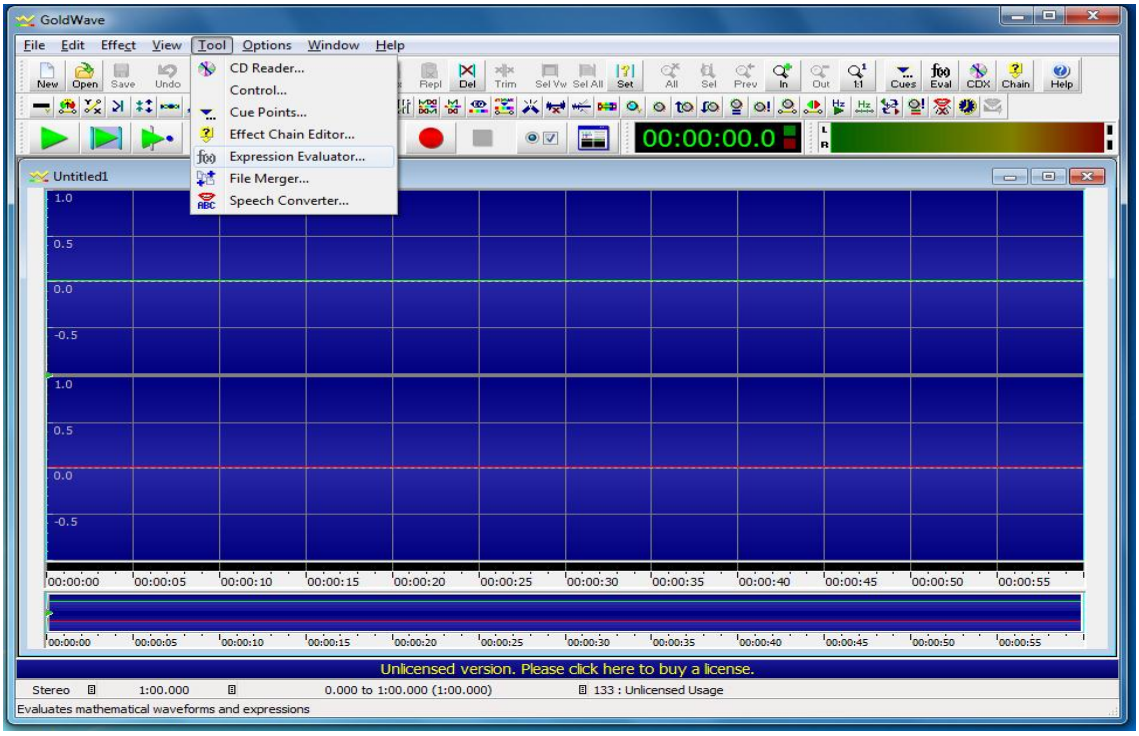


Figure 44: Step 4 - 4

5. The Expression evaluator window should appear. Here it is possible to create a variety of wave forms. This time choose a pure sine wave with a frequency of 444 Hz or 1 KHz and press OK. (Figure 45)

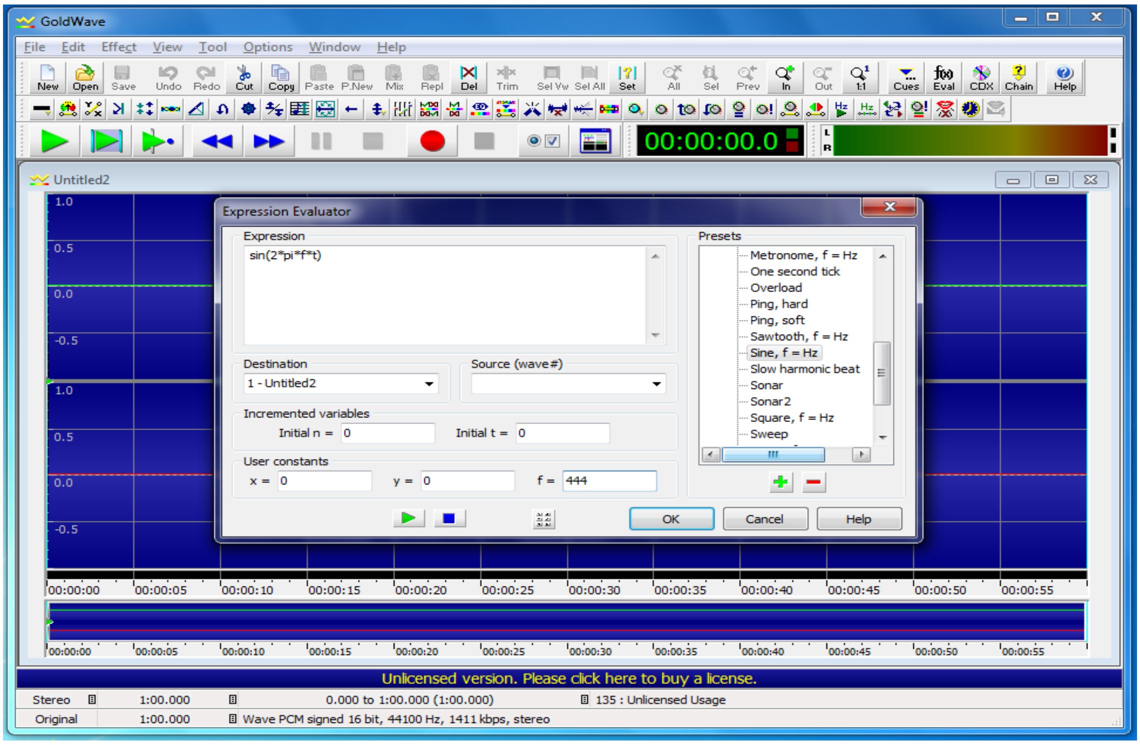
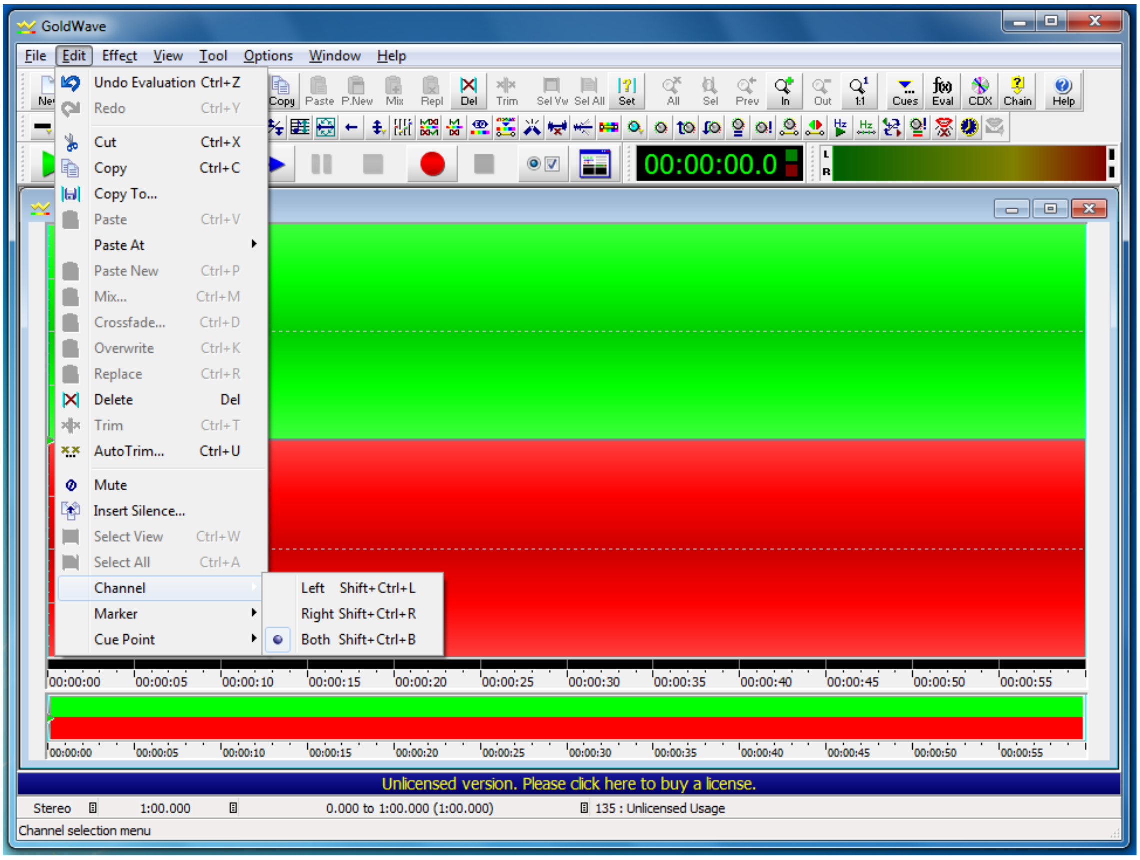


Figure 45: Steps 4 - 5

6. Select Edit menu => Channel =>choose Left or Right, but not both. (Figure 46)Figure



46: Step 4- 6

7. Select Effects menu => Invert and play the sound. (Figure 47)

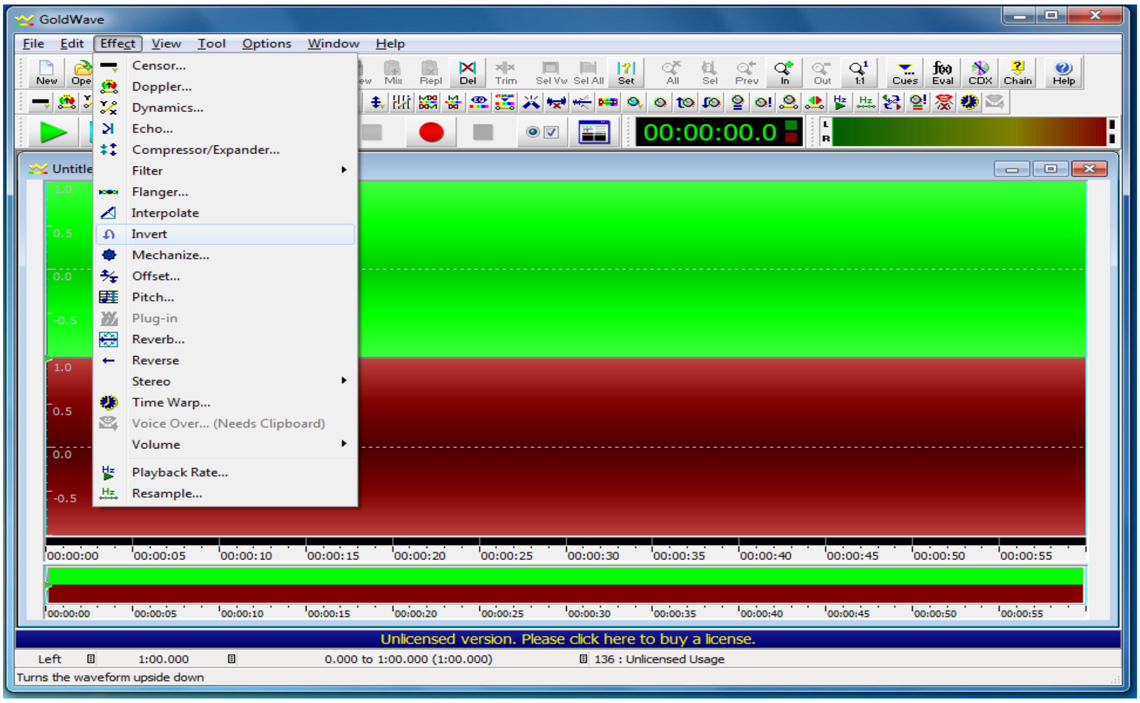


Figure 47: Step 4 - 7

8. Start to measure decibel differences between the sound levels and note the difference by hearing.

5 TESTING

5.1 Acoustic short circuit test

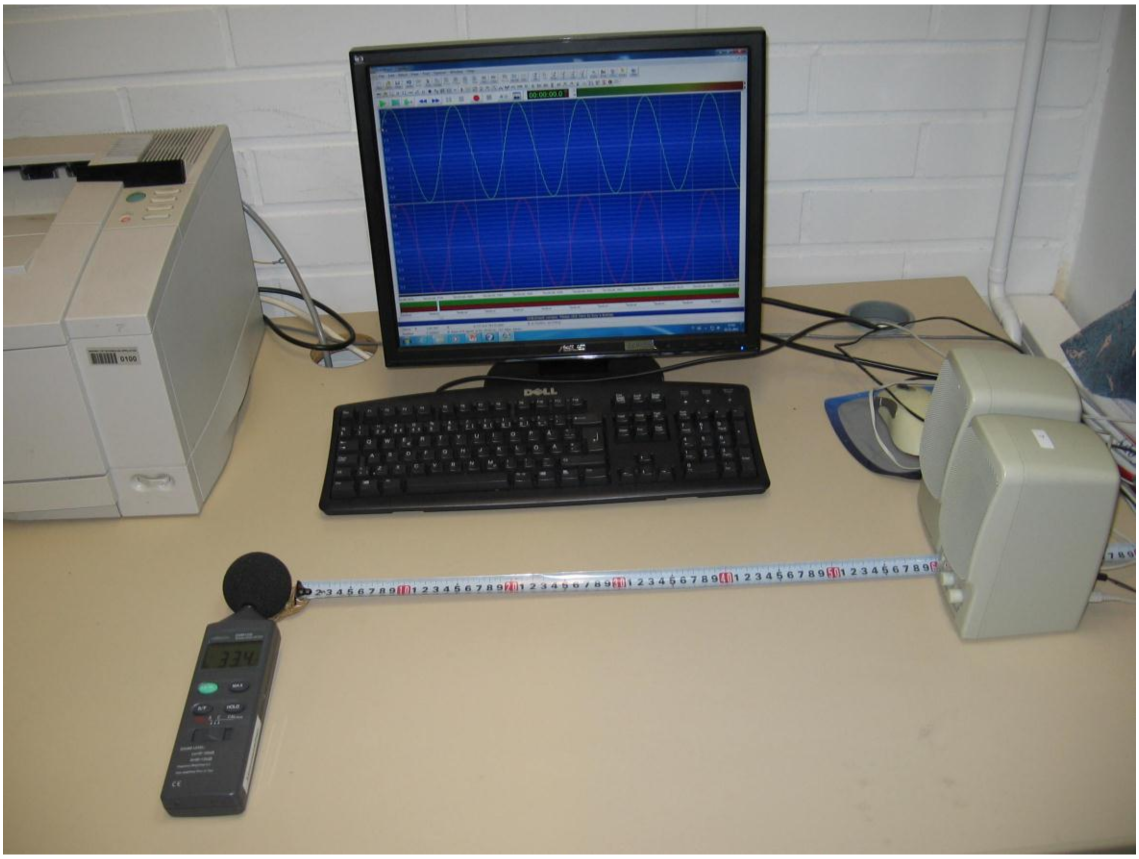


Figure 48: Acoustic short circuit equipment

The equipment needed in this lab is: (Figure 48)

- PC- Loudspeakers
- Computer
- A Tape Measure
- A digital sound level meter
- Pencil and rubber
- A paper includes a schedule measurement

Verify that the PC-loudspeakers are connected to the computer. Start one of the sound programs e.g. Gold Wave with two mono channels. The frequency is one kilo hertz and the initial file length 10 minutes. Place them to face in opposite directions. Choose the left or right channel from Edit menu. Invert the sound wave of the channel from the Effects menu and play the voice. Change the distance between the loudspeakers to become close. Remove the inversion and play the voice again. Write down your observations. What was the difference between both situations and what is the reason for this phenomenon?

Task 2:

Place loudspeakers side by side about one meter far from a digital sound level meter and use the same wave form as in task 1. Put on the A-weighted mark (Find out what the A-weighted means?). A digital sound level meter should definitely be directed towards the loudspeakers. Adjust the volume of sound and calibrate the measuring arrangement. When the digital sound level meter is shown about 70 db, start to calibrate the distance and enter the values in the table below. (Figure 49, Figure 52)

db	Distance

Figure 49: Table for decibels and distance measurement

The result for our test was as figure below: (Figure 50)

Frequency	Wave lenght	Half wave
Taajuus	Aallonpituus	½-aalto
1000	0.343	0.1715

db	Etäisyys (cm)		
70	0		
47.2	18.4	18.4	Keskimäärin
74.8	41	22.6	84.5
63.1	56	15	16.9
74.1	66	10	
65	84.5	18.5	

Figure 50: test results for acoustic short circuit

Sample result generator (Figure 51)

Hertz	λ	λ/2
1300	0.263846154	0.131923077

	Value	cm
Value 1	High	0
Value 2	Low	0.131923077
Value 3	High	0.263846154
Value 4	Low	0.395769231
Value 5	High	0.527692308
Value 6	Low	0.659615385
Value 7	High	0.791538462
Value 8	Low	0.923461538
Value 9	High	1.055384615
Value 10	Low	1.187307692
Value 11	High	1.319230769

Figure 51: Sample result generator

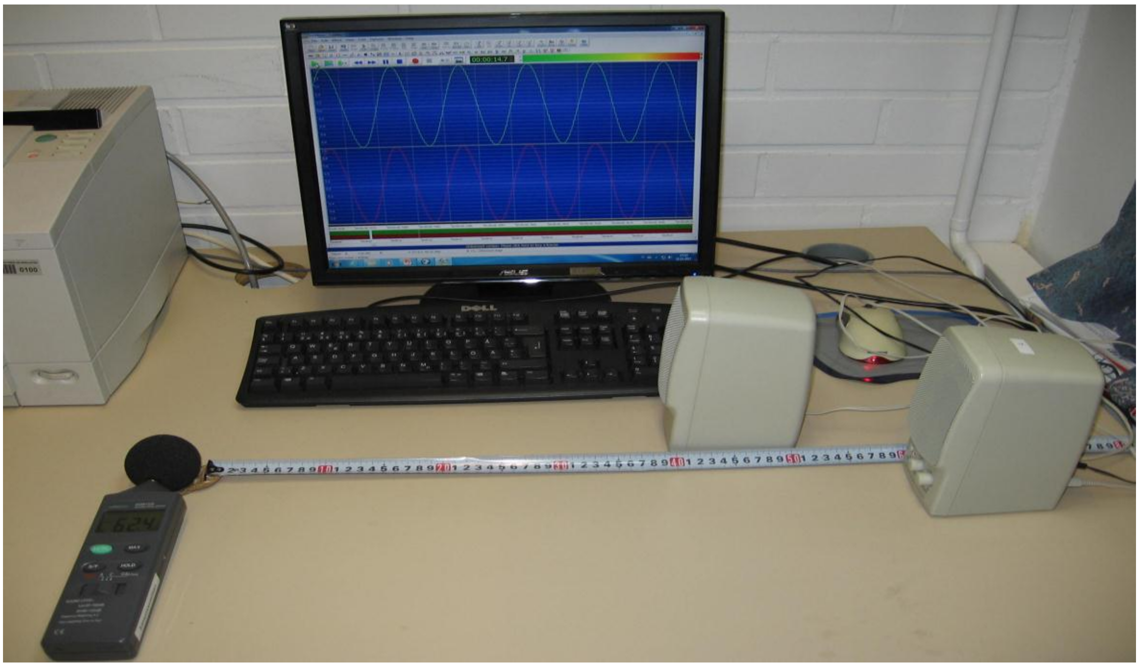


Figure 52: The distance calibration and decibel measurement

5.2 Dew point measurement test

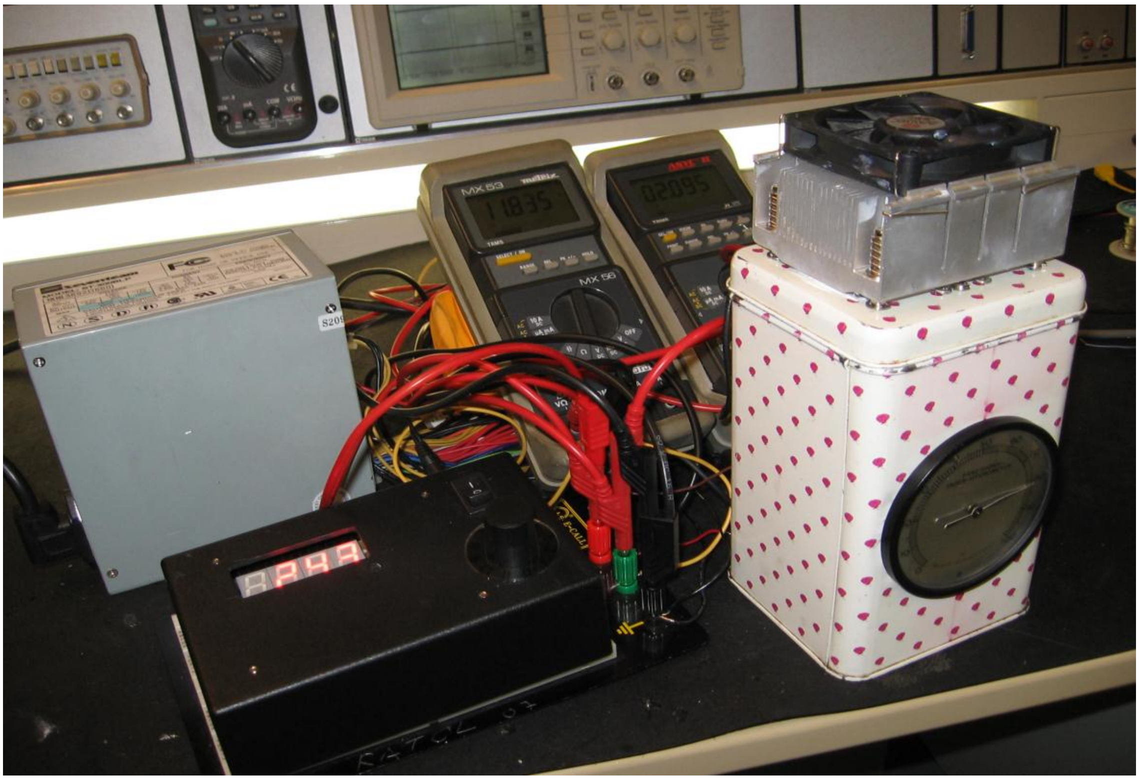


Figure 53: The equipment of dew point measurement

The equipment needed in this lab is: (Figure 53)

- Humidity simulation device
- Power supply (12 V / 10 A)
- Digital thermometer

If a suitable power source is not available, you can use the computers power supply that gives 12 V in yellow wire. Humidity simulation device contains the artificial processor which consumes 2.15 A by 12 V

WARNING!

Do not leave the artificial processor without monitoring because the too high temperature produced by it will lead to damage it.

Task 1:

Before you begin, write down the dew point measurement and the temperature inside the humidity simulation device. In addition, write down the room temperature.

Connect the artificial processor to a power supply and monitor the humidity and the temperature of the device case every 30 seconds by digital thermometer until temperature reaches 30 degrees Celsius inside the case.

Note 1: The artificial processor temperature should not be over the 100 degrees Celsius.

Note 2: The artificial processor temperature is not the same as device case temperature. When the device case temperature almost equals to 30 degrees Celsius, the artificial processor is almost equals to 105 degrees Celsius.

Switch off the power from the artificial processor and write down the values of humidity and temperature every 30 seconds, in addition the observations.

Tray the test again and add two drops of water on the artificial processor and write down your observations.

Task 2:

As in the previous exercise (Task 1) when you switch off the artificial processor connect the cooling system element to a power supply directly and write down the values of humidity and temperature every 30 seconds, in addition the difference between both situations.

The results for our test was as figure below (Figure 54 – Figure 55)

Dewpoint measure / Kastepistemittaus

Measurer/ Mittaaja: Imad Date / PVM: 11/26/2011

Class / Luokka: DIT6SN

Room temperature / Huoneen lämpötila 21.5 °C Moisture % / Kosteus % 52 %

HEATING / LÄMMITYS COOLING / JÄÄHDYTYS

	Lämpötila	Kosteus %	Keino Pros Lämpö	Time	Lämpötila	Kosteus %	Keino Pros Lämpö	
0	20.2	54		0	32.7	60		
30	20.3	55		30	32.9	60		
60	20.5	55		60	32.7	59	100 astetta!	
90	21	55		90	32.4	58		
120	21.5	56		120	32.1	57		
150	22.3	57		150	31.7	56.5		
180	23	57		180	31.3	55.5		
210	24	58		210	30.9	54.5		
240	24.8	58.5		240	30.6	53.5		
270	25.8	59		270	29.9	53		
300	26.8	59.5	100 astetta!	300	29.6	52.5		
330	27.9	60		330	29	52		
360	28.7	60		360	28.5	51.5		
390	29.6	60		390	27.7	51		
420	30.5	60		420	27.3	50.5		
450				450	26.3	50		
480				480	25.7	50		
510				510	25.3	50		
540				540	24.9	50		
570				570	24.8	50		
600				600	23.9	49.5		
630				630	23.6	49.5		
660				660	23.2	49		
690				690	22.9	49		
720				720	22.9	49		
750				750	21.7	49		
780				780	21.8	49		
810				810	20.7	49		
840				840	20.2	49		
870				870	19.6	48.5		
900				900	19.4	48.5		
930				930	19.4	48.5		
960				960	19.2	48.5		40
990				990	18.6	48.5		
1020				1020	18.3	48		
1050				1050	18	48		

Figure 54: The result of dew point measurement

1020		
1050		
1080		
1110		
1140		
1170		
1200		
1230		
1260		
1290		
1320		
1350		
1380		
1410		
1440		
1470		
1500		
1530		
1560		
1590		
1620		
1650		
1680		
1710		
1740		
1770		
1800		
1830		
1860		
1890		
1920		
1950		
1980		
2010		
2040		
2070		
2100		

1020	18.3	48	
1050	18	48	
1080	17.4	48	
1110	17.2	48	
1140	16.8	48	
1170	16.8	48	
1200	16.7	48	
1230	16	48	
1260	16.2	48	
1290	16	48	
1320	15.8	48	
1350	15.5	48	
1380	15.6	48	
1410	15.2	48	
1440	15.2	48	
1470	14.9	48	
1500	14.8	48	
1530	14.6	48	
1560	14.5	48	
1590	14.5	47.5	
1620	14.5	47.5	
1650	14.3	47.5	25.6
1680	14.3	47.5	
1710	14.2	47.5	
1740	14.1	47.5	
1770	13.9	47.5	
1800	13.9	47.5	
1830	13.7	47.5	
1860	13.5	47.5	
1890	13.7	47.5	
1920	13.5	47.5	
1950	13	47.5	
1980	13	47.5	21.9
2010	13.1	47.5	
2040	13.1	47.5	
2070	13	47.5	
2100	13	47.5	
2130	12.7	47.5	20.2
2160	12.7	47.5	
2190	12.4	47.5	
2220	12.4	47.5	
2250	12.5	47.5	
2280	12.5	47.5	
2310	12.5	47.5	
2340	12.3	47.5	
2370	12.3	47.5	
2400	12.3	47.5	
2430	12.2	47.5	
2460	12.4	47.5	
2490	12.2	47.5	

Figure 55: The result of dew point measurement

5.3 Heat transfer measurement test

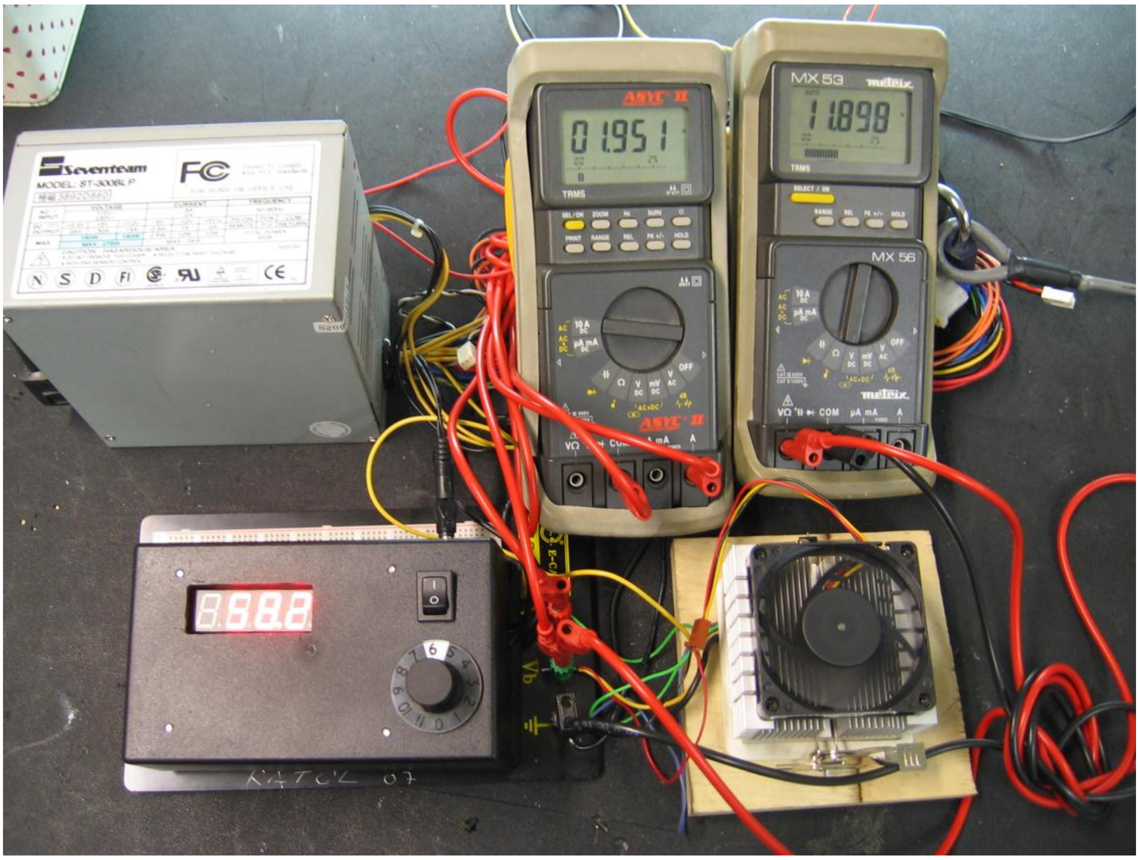


Figure 56: The equipment of heat transfer measurement

In the thermal transition experiments study is to learn how used device is warming because of a power consumed, and how different kind of cooling solutions work. For these exercises you need: (Figure 56, Figure 60)

- An artificial processor which is equipped with internal temperature sensor
- A digital thermometer
- A power source (min. 12 V / 3 A)
- A passive cooling element and a fan, which can be attach to cooling element.
- A timer watch.

Exercises:

Exercise 1: The usage voltage is about 12 V. Calculate how much is the power of the artificial processor, if there are 100 pieces of resistors (each one has a 560 Ohms) in parallel inside it?

Exercise 2: Calculate the needed current for the artificial processor?

Exercise 3: The side length of the artificial processor is 7 cm. calculate the power density on the surface of the artificial processor?

Tasks:

Check that the power supply is turned off. Connect the artificial processor to the power source and sensor cable to the digital thermometer. Switch on the digital thermometer and find the channel where is the temperature of the artificial processor. Measure also room temperature!

WARNING!

Do not leave the artificial processor without monitoring because the too high temperature produced by it will lead to damage it.

Task1: Measure how long the temperature of the artificial processor will takes to arise from room temperature to 100 °C. Measure the temperature of the artificial processor before you connect any voltages in it. Switch on the voltage and observe the temperature behavior. Write down the values to paper every 30 seconds until temperature reaches to 100 °C.

Task 2: Let the temperature of artificial processor arise about 105 degrees of Celsius. When the temperature is 100 degrees, start timer watch to measure time. Install passive cooling element on the processor and register the values every 30 seconds on the sheet as in previous exercise.

Task 3: Let the temperature of artificial processor arise about 105 degrees of Celsius. When the temperature is 100 degrees, start timer watch to measure time. Install active cooling element (A heat sink with a fan) on the processor and register the values every 30 seconds on the sheet as in the previous task.

Task 4: Let the temperature of artificial processor go down to the level of room temperature. If needed, you can help it by using cold spray. Install passive element on the artificial processor. Mark up the beginning value on the sheet and connect the power to the artificial processor. Measure as many values as in the previous task and register the values every 30 seconds.

Task 5: Let the temperature of artificial processor go down to the level of room temperature. If needed, you can help it by using cold spray. Install active element on the artificial processor.

Mark up the beginning value on the sheet and connect the power to the artificial processor. Measure as many values as in the previous task and register the values every 30 seconds.

Example of heat transfer measures table (Figure 57)

Heat transfer measures / Lämpösiirtymä mittaus.

Measurer/ Mittaaja: ________ Date / PVM: ________

Class / Luokka: ________

Room temperature / Huoneen lämpötila: ________

Artificial processor / keinoprosessori:		Passive element / Passiivijäähdytys:		With Fan / Tuulettimella	
Time / Aika	°C	Time / Aika	°C	Time / Aika	°C
0		0		0	
30		30		30	
60		60		60	
90		90		90	
120		120		120	
150		150		150	
180		180		180	
210		210		210	
240		240		240	
270		270		270	
300		300		300	
330		330		330	
360		360		360	
390		390		390	
420		420		420	
450		450		450	
480		480		480	
510		510		510	
540		540		540	
570		570		570	
600		600		600	
630		630		630	
660		660		660	
690		690		690	
720		720		720	
750		750		750	
780		780		780	

Figure 57: Heat transfer measures table

The results for our test was as figure below (Figure 58, Figure 59)

Heat transfer measures / Lämpösiirtymä mittaus.

Measurer/ Mittaaja: Imad Abdulla Date / PVM: 6/7/2011

Class / Luokka: DIT6SN

Room temperature / Huoneen lämpötila: 21.5

Voltage / Jännite 10 V Current / Virta 1.76

Power / Teho 17.6 W A

	Artificial processor / keinoprosessori: Time / Aika	°C	Passive element / Passiivijäähdytys: Time / Aika	°C	With Fan / Tuulettimella Time / Aika	°C
1	0	20.6	0	20	0	21.6
2	30	31.1	30	28.5	30	29.3
3	60	41.8	60	36.4	60	36.9
4	90	50	90	42.3	90	42.8
5	120	57.4	120	46.5	120	47.1
6	150	64	150	50.2	150	50.4
7	180	70	180	53.1	180	53.1
8	210	75.7	210	55.5	210	55.3
9	240	80.8	240	57.8	240	57.3
10	270	85.5	270	59.5	270	58.9
11	300	90	300	61.3	300	59.9
12	330	94	330	63	330	60.8
13	360	97.9	360	64.4	360	61.6
14	390	101.3	390	65.7	390	62.2
15	420	105.2	420	67.1	420	62.7

Figure 58: The results of heat transfer measures

Down from 100°C

Passive cooling / Passiivijäähdytys:

Time / Aika	°C
0	100
30	89.5
60	87.6
90	87.1
120	87
150	87.2
180	87.6
210	88.1
240	88.6
270	89.1
300	89.6
330	90.1
360	90.6
390	91.1
420	91.6

Active Cooling / Aktiivijäähdytys:

Time / Aika	°C
0	100
30	92.7
60	87.8
90	84.1
120	81.5
150	79.5
180	78
210	76.3
240	75.1
270	74.3
300	73.6
330	73.1
360	72.7
390	72.4
420	72.2

Figure 59: The results of heat transfer measures

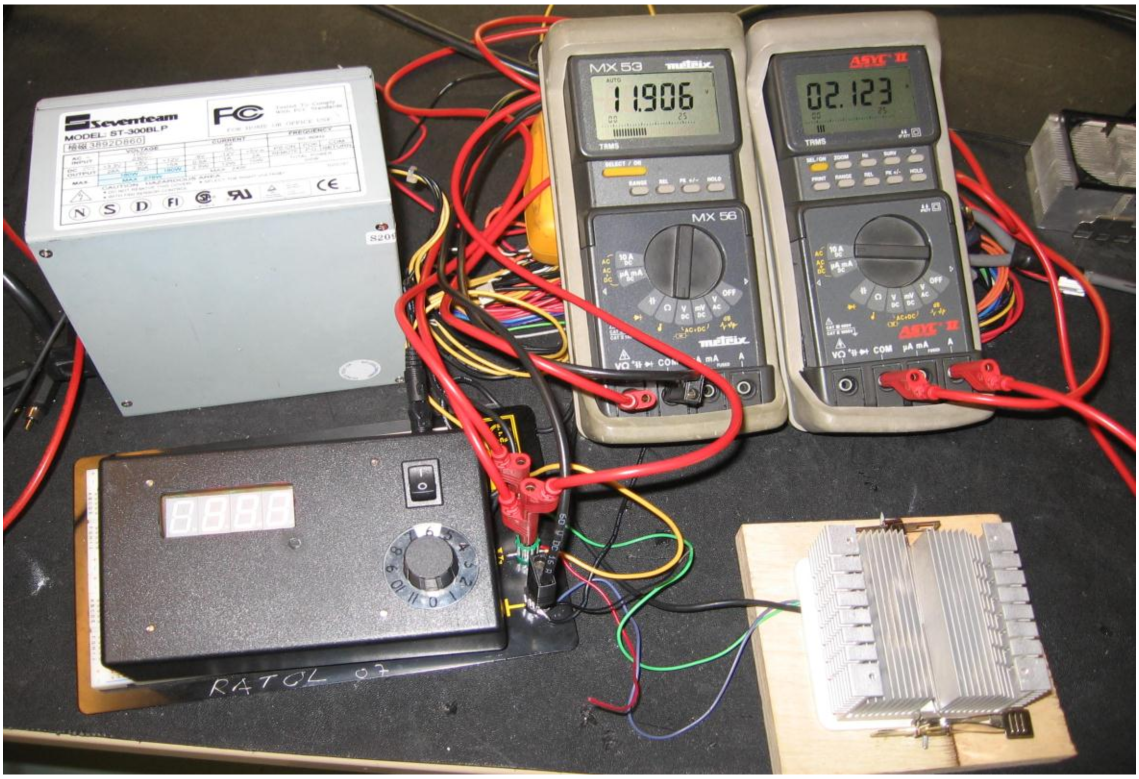


Figure 60: The equipment of heat transfer measurement

6 POSSIBILITIES OF FURTHER DEVELOPMENT

Going further with the experiments, we could later measure the energy consumptions of the tasks. To measure air flows, we could later use more sophisticated air flow measurement devices, if available. For temperature measurements, it is possible to get more detailed results by measuring the temperatures of separate computer parts. Also, noise pollutions could be measured from a wide range of electrical devices. In future, additional measurements, such as a power density measurement, could be done.

7 CONCLUSION

The result of the study shows the various factors that affect the performance of a computer system. It is important to note that temperature, pressure and humidity affect the performance of a computer significantly. Therefore, necessary precautions should be taken in order to avoid damaging the computer by ignoring the effects of some of these factors.

The aims of these laboratories have been achieved successfully. The main purpose of this work was to design devices and modify a computer to display different parts as objects for different kinds of measurements. The purpose of this project was also to provide instructions for the necessary steps when making these devices.

With the help of these devices, students can become more familiar with the computer technology, overcome their fears towards technologies and finally start building their own devices.

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APPENDICES

Some problems occurred during the tests such as short circuit inside the artificial processor as in figures below: (Figure 61, Figure 62)

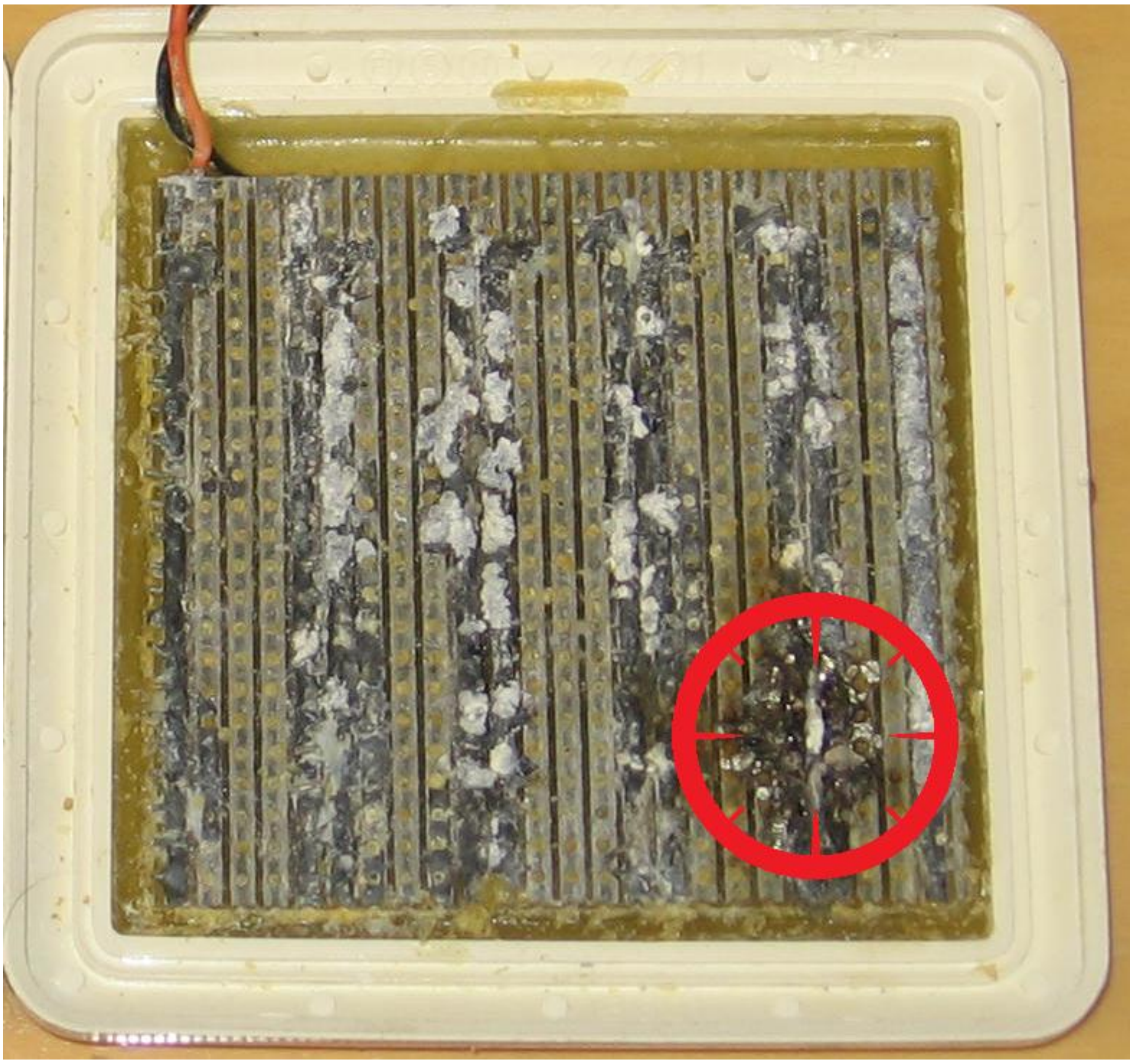

Figure 61: The result of short circuit in the artificial processor

Figure 62: Comparison between the burning device and the proper device